AGRICULTURAL ENGINEERING

MARCH • 1954

In this Issue . . .

Design and Development of a High-Speed Agricultural Mower

•

A Study of Contemporary British and European Farm Tractors

•

A Simple Slide Rule for Soil Moisture Determinations

•

Recent Developments in Machinery for Fertilizer Application

•

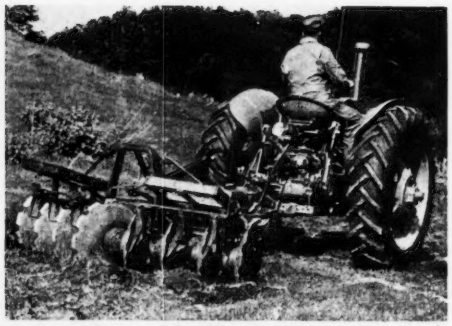
The Proportioning System of Potato Storage Ventilation

ASAE 47th Annual Meeting • Minneapolis, Minn., June 20-23

THE JOURNAL OF THE
AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

Conservation Methods
Made Easy...Economical

Full-width furrows on contour curves. Break-Away mounted plow pulls beams and bottoms from proper pivot-point of plow frame—to prevent cutting in or out on curves. Break-Away safety release, also built into plow, prevents damage by buried stones or stumps. Two and 3-bottom sizes. For all three sizes of Case Tractors with Eagle Hitch.



Pasture Renovation Harrow has 24 or 26-inch blades spaced 10½ inches apart to bite deep in hard, sod-bound, overgrown soil. Makes way for lush grass on rough, stony, stumpy land.

Field Shredder slashes and beats trash into bits, to remain as mulch or mix with soil for humus formation. Shreds corn and cotton stalks, potato vines, sage brush, other wild growth and crop residues.

Six-Cylinder...5-Plow CASE DIESEL Tractor

Wide One-Way Plow turns soil to receive and retain rain, sets stubble to resist blowing, hold soil and snow. Sizes to cut 12, 15, or 18 feet wide, easily adjust to trail for transport. Tandem rear wheels, one running on unplowed land, the other in furrow, give positive depth control in uneven ground.

Soil and water conservation practices are essentially good farming, and should be applied mainly with regular farm machinery. Case implements are designed with an eye to making such conservation methods easy and economical.

The new Case Diesel Tractor, shown at left, is available factory-equipped with power steering, also with constant power take-off and dual-valve constant hydraulic control, making it the most complete of farm diesels. Multiple cylinder heads, single-plunger injection pump, and a six-point fuel filtering system combine diesel fuel economy with the upkeep economy for which Case machines are known. J. I. Case Co., Racine, Wis.

CASE

New Holland Machine Company

BUILDS NEW, BETTER BALER...

It's BLOOD BROTHERS EQUIPPED!

Just announced by New Holland, this fast Model 66 PTO Baler includes three Series L14N Blood Brothers Joints, with Integral Safety Shields on front shaft section.

As new, better implements are built for P.T.O. operation, you'll likely find them equipped with Blood Brothers Universal Joints and Drive Lines . . . and for good reasons.

First, Blood Brothers' engineers have cooperated with implement builders for years, working out mutual problems to insure dependable, low-cost drive lines.

At the same time, exacting standards have maintained top quality through every step of joint manufacture. Excellent field performance has resulted . . . earning widespread respect from manufacturers, dealers and farmers.

Take advantage of this helpful reputation when you build — or sell — an implement. *Saleability increases when it's Blood Brothers equipped!*

FOR FARM IMPLEMENTS, MORE BLOOD BROTHERS UNIVERSAL JOINTS ARE USED THAN ALL OTHER MAKES COMBINED.

TAKES POWER AROUND CORNERS

BLOOD BROTHERS machine division

Rockwell Spring and Axle Company

ALLEGAN, MICHIGAN

AGRICULTURAL ENGINEERING

Established 1920

CONTENTS • MARCH, 1954 • VOL. 35, NO. 3

The Design and Development of a High-Speed Mower 147
L. E. Elfes

Unified National Electric Fence Code Needed 154
C. L. Hamilton

Contemporary British and European Tractors 155
Wayne H. Worthington

A Slide Rule for Soil Moisture Determinations 163
Elmer F. Rowland, T. D. Fagan, and George A. Crabb, Jr.

New Developments in Fertilizer Machinery 165
C. E. Guelle

The Georgia-USDA Peanut Harvester 168
Charles E. Rice and James H. Ford

Introducing Fertilizer Solutions into High-Pressure Irrigation Systems 171
E. R. Allred and J. H. Pomroy

Some Anomalies in the Determination of Moisture 173
W. R. Fetzer

Potato Storage Ventilation 176
J. W. Layer, L. L. Boyd, and B. C. Haynes, Jr.

News Section 179

Index to Advertisers 200

Note: AGRICULTURAL ENGINEERING is regularly indexed by Engineering Index and by Agricultural Index. Volumes of AGRICULTURAL ENGINEERING, in microfilm form, are available (beginning with Vol. 32, 1951), and inquiries concerning purchase should be directed to University Microfilms, 313 N. First St., Ann Arbor, Michigan.

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RAYMOND OLNEY
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ADVERTISING REPRESENTATIVES

Chicago 2:
DWIGHT EARLY & SONS
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SUBSCRIPTION PRICE: $4.00 a year, plus an extra postage charge to all countries to which the second-class postage rate does not apply; to ASAE members anywhere, $3.00 a year. Single copies (current), 40 cents each.

POST OFFICE ENTRY: Entered as second-class matter, October 28, 1933, at the post office at Benton Harbor, Michigan, under the Act of August 24, 1912. Additional entry at St. Joseph, Michigan. Acceptance for mailing at the special rate of postage provided for in Section 1103. Act of October 3, 1917, authorized August 11, 1921.

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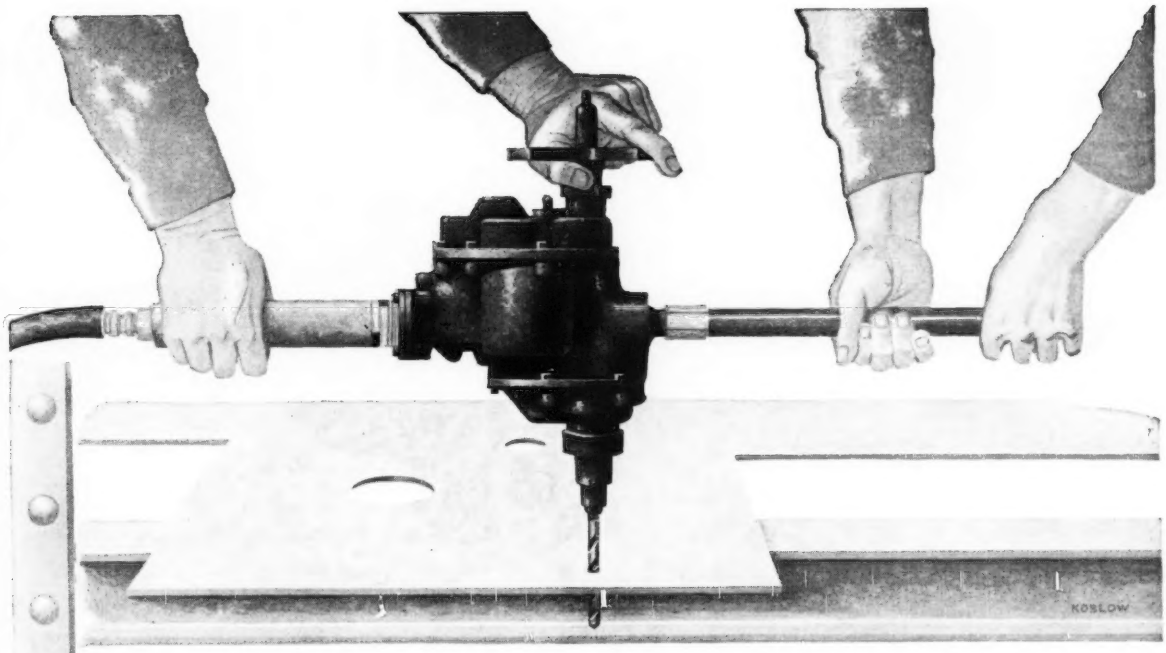


Need high capacity, long service life, small size?

here's how leading manufacturers of pneumatic tools get them with NEEDLE BEARINGS

Torrington Needle Bearings are used in many leading brands of pneumatic tools because of their ability to take heavy loading, their compactness, and their long life.

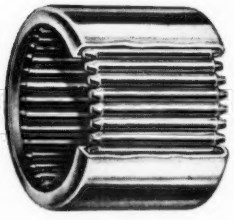
In wrenches, nut runners, drills, rivet hammers, impact and many other types of air-driven tools, the Needle Bearing's ability to boost power output and torque, while saving weight and space, has been proved again and again.

On spindles, idler gears, planetary gears and angle attachments, Needle Bearings enable tool designers to keep tools compact and light. They cost little more than plain bearings, yet they give high-capacity performance over long periods with minimum maintenance.

Throughout industry, Torrington Needle Bearings have become "standard equipment" since their introduction nearly twenty years ago. When space is limited and high capacity is a "must," specify Needle Bearings.

Why not learn whether the Needle Bearing can benefit your products. Our engineers will be glad to assist you.

THE TORRINGTON COMPANY
Torrington, Conn. • South Bend 21, Ind.



TORRINGTON NEEDLE BEARINGS

Needle • Spherical Roller • Cylindrical Roller • Tapered Roller • Ball • Needle Rollers

Trade-marks of leading pneumatic tool manufacturers whose products enjoy the benefits of Needle Bearings.

Ingersoll-Rand · Mall · Buckeye Tools Corporation · Cleco Air Tools · Porter Cable · K Keller Tools · Sundstrand · Milwaukee · Thor · NS National Air Sander · Rotor Tool · ARO

ANOTHER NEW FAFNIR...

Ball Bearing "Economy Package"

Type PB Pressed Steel Pillow Block

The new Type PB Series Pillow Block is developed to fill a specific need for a high-quality, precision ball bearing unit at the lowest possible cost. It is made for *light duty* applications where a low-cost "packaged" unit offers definite manufacturing and servicing advantages . . . on agricultural equipment, conveyors, light-duty fans and similar types of machinery involving the transmission of power.

The Type PB Series Pillow Block opens up new opportunities to add extra product sales features and to lower maintenance costs . . . another example of the Fafnir "attitude and aptitude". Send for new, descriptive bulletin. The Fafnir Bearing Company, New Britain, Conn.

OUTSTANDING FEATURES

- Low Cost
- Precision Ball Bearing . . . Fafnir Wide Inner Ring Bearing* with Self-locking Collar and efficient Plya-Seals.
- Two-piece separable pressed-steel housing.
- Self-aligning . . . unrestricted in all directions at assembly.
- Occupies less space than other pillow blocks.
- Light weight . . . combined with ample strength.
- Only two bolt holes required in assembly.
- Ample capacity for radial, thrust or combined loads.
- Pre-lubricated with long-life grease.
- Available for shaft sizes ½" to 1¼" inclusive.

*Easiest bearing of all to install. Counterbored, eccentric, mated cam construction of collar and inner ring assures positive locking action without set screws, lock nuts or adapters.

FAFNIR
BALL BEARINGS
MOST COMPLETE LINE IN AMERICA

CHECK these important differences in augers for farm machines

- **ONE-PIECE HELICOID FLIGHTING** has greater smoothness and strength. Link-Belt also builds many different shapes in various metals to meet your specific needs—cut flight, short pitch, ribbon flight, tapering, double flight to name a few.
- **UNIFORM PITCH** — Specialized modern machinery assures accurate forming, producing uniformity in flighting curvature.
- **ONLY SPECIALLY SELECTED STEELS** are used to meet Link-Belt's rigid specifications — assuring smooth flight surfaces.
- **STRAIGHTNESS** is checked before shipping and extra care is taken in handling and loading.

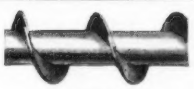
Complete auger for this harvester-thresher is furnished by Link-Belt. Opposed flights move cut grain to center, deliver it to pick-up conveyor.

LINK-BELT gives you sound engineering plus accuracy of manufacture for top performance

WHEN you make a Link-Belt auger part of your farm machine, you can be sure of efficient operation plus long-life, low-maintenance service. Link-Belt builds augers for every purpose—gathering cut grain back of the sickle bar, conveying, elevating, spreading, feeding, mixing or digging.

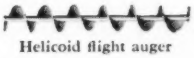
Each can be engineered for your specific requirements . . . each will provide long-lasting efficiency, thanks to Link-Belt's unequalled accuracy of manufacture. Let your nearby Link-Belt sales representative point out the many important differences in augers to you. And be sure he gives you a copy of Book 2289, covering Link-Belt's regular line of conveyor screws and components.

Typical examples of Link-Belt Augers



Sectional-flight

Helicoid flight with end, plain beater



Helicoid flight auger

Opposed flights with center saw-tooth beater

Unmounted Helicoid flighting

LINK-BELT

FARM MACHINE AUGERS

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N. S. W.; South Africa, Springs. Representatives Throughout the World.

13.384

HOW FARM POWER CONTRACTORS ARE CLEARING LAND FASTER AND EASIER...

With a FLECO Rock Rake, this D6 clears timber and brush. Outfit concentrates the tractor push on stumps or brush and sifts soil from roots without moving excessive dirt.

This Cat D6 Tractor pulls a heavy-duty Rome plow through dense palmetto. This outfit can work through most scrub growth and heavy brush up to 2" thick, reducing it to chopped residue in one operation.

Farm power contractors have chosen Cat® Diesel Tractors as their No. 1 earthmoving, land clearing power for the simple reason that they can depend on them to stay on the job and cost less to operate. As a result, Caterpillar track-type Tractors have moved more dirt . . . cleared more land than any other man-made power on earth! Now, a variety of specialized tools make land clearing even more efficient than ever. Illustrated here are a few . . . for complete information, write us.

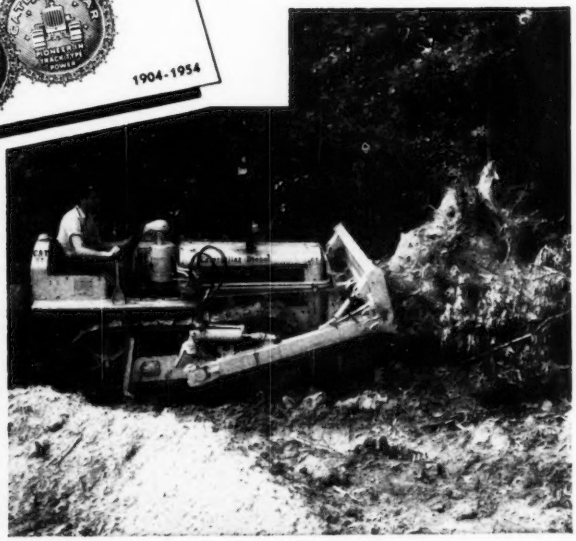
Caterpillar Tractor Co., Peoria, Ill., U.S.A.

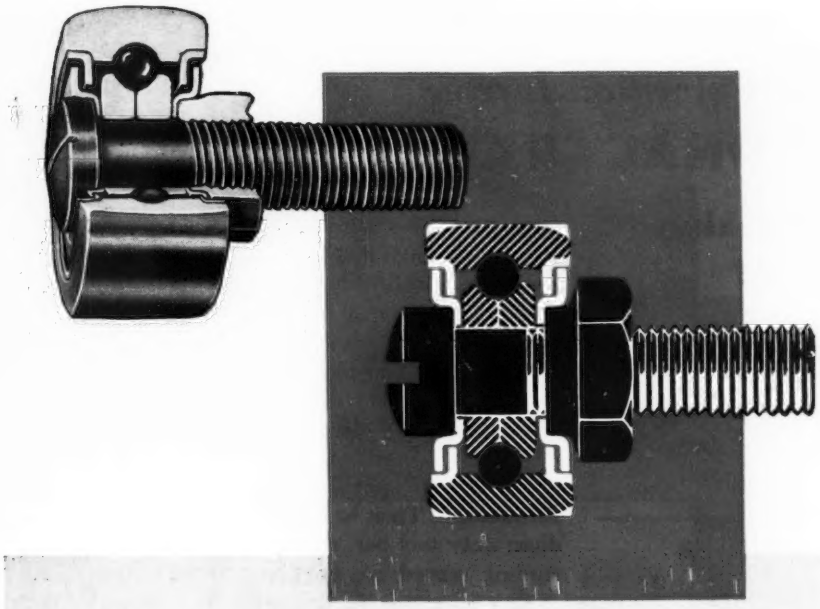
Diesel Farm Tractors • Tool Bars • Implements

CATERPILLAR®

Though the Cat D4 Tractor develops about the same horsepower as large wheel-type tractors it has about twice the push or pull power. Its 10,600 pounds of push or pull make it an ideal farm-owned tractor for land clearing. Shown equipped with FLECO® Tree Cutter.

The Cat-built Bulldozer is the favored method of land clearing, because of its universal use. Works equally well for earthmoving. Low cost tool bar 'dozer shown on the Cat D2 Tractor.





Low in original cost, BCA Cam Follower Bearings cut installation costs, too!

This *package unit* includes a pre-lubricated sealed bearing and a mounting stud. So, in addition to costing less initially, BCA Cam Follower Bearings save substantially on installation time.

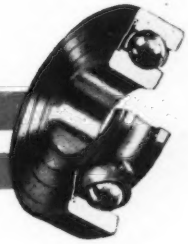
BCA Cam Follower Bearings stand up to the terrific punishment of agricultural service. They give outstanding performance used in connection with hay baler cams and in forage harvester pickup attachments. The thick-sectioned outer race is case hardened to withstand the shock common to these cam applications. BCA cam follower bearings are slightly crowned to assure better contact with the cam.

BCA has made many contributions to the solution of the bearings problems peculiar to farm equipment. Perhaps we can solve *your* bearings problems.

BCA

radial, thrust, angular-contact Ball Bearings

BEARINGS COMPANY OF AMERICA
DIVISION OF FEDERAL-MOGUL CORP.
LANCASTER • PENNSYLVANIA

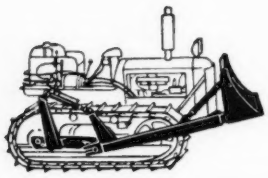


A report to you about the men and machines that help maintain International Harvester leadership.

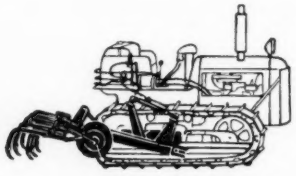
NEW McCormick® combination carrier for INTERNATIONAL® CRAWLERS

...one frame for dozing and tool bar tillage!

Simply head in for dozing



back in for tillage!



It's the new McCormick combination dozer and tool bar, for International 6 and 9 series crawlers. Booms are dozer *push bars*, also tool bar *draft* members.

This new way, a farmer can profitably use his crawler tractor extra hundreds of hours per year. At minimum cost, he can do both heavy-duty tillage and farm dozing – and thus increase earning power from his crawler tractor investment.

The farmer buys the basic machines: booms, mounting plates, hydraulic cylinders and hoses, and turnbuckles. Then he can select blade, heavy or medium duty tool bar, and ground-working tools, according to need; pay only for what he wants.

By easy stages, he can equip his crawler for both dozing and tillage work. He can take effective conservation steps – employ modern soil-working methods, including *deep* and *stubble-mulch* tillage.

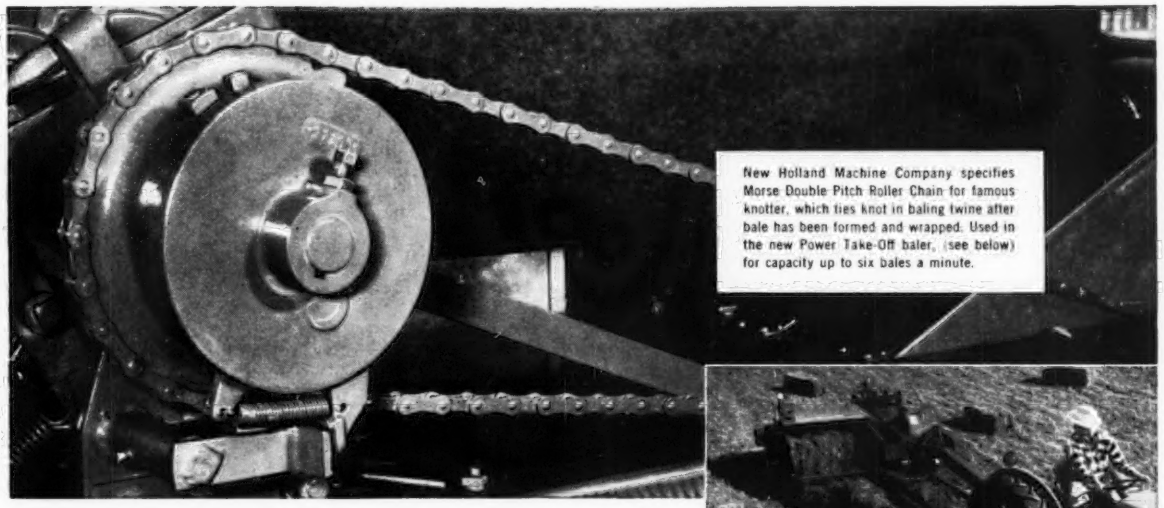
Build ponds, clear land, make contours, move dirt—do anything any farm dozer will do, with the big capacity blade for the new McCormick combination carrier.

Ditch, subsoil, chisel, stubble-mulch, list, furrow, field cultivate, check, bed, with the McCormick combination carrier equipped with tool bar.

International Harvester engineering teamwork produced the new McCormick combination carrier. International Harvester research, engineering and manufacturing men are constantly pooling their time and talent to provide equipment that makes work easier and the farmer's time more productive.

INTERNATIONAL HARVESTER

International Harvester products pay for themselves in use—McCormick Farm Equipment and Farmall Tractors ...Motor Trucks...Crawler Tractors and Power Units...Refrigerators and Freezers—General Office, Chicago 1



New Holland Machine Company specifies Morse Double Pitch Roller Chain for famous knotter, which ties knot in baling twine after bale has been formed and wrapped. Used in the new Power Take-Off baler, (see below) for capacity up to six bales a minute.

Quick refresher facts

ON MORSE DOUBLE PITCH CHAINS

You gain parts economy and increased customer satisfaction when you equip your farm machinery with Morse Double Pitch Chains.

DESIGN, ECONOMY FACTORS

You cut problems raised by gradual pitch elongation to a new low with these tough, precision-built, steel chains. Your customers will welcome freedom from maintenance cost, time loss and annoyance.

Morse Double Pitch Chains come in two series, *Power Transmission* and *Conveyor*. Both series are adaptable to a maximum range of applications, can be used with standard and special attachments.

Double Pitch Chains are ideally suited for applications where rotative speeds are low and the power to be transmitted is within the capacity of a single strand chain. In comparison with standard roller chains, they weigh less, cost less; with proper care, they provide the same long life. Parallel strands wear evenly—a particular advantage for conveying work.

STAMINA FACTORS

Morse Double Pitch Chains will wear longer, give more satisfactory, all-round performance, help reduce downtime. Here are a few reasons:

1. PINS. Heat-treated special high-nickel, fine grain alloy steel pins have extremely hard case for wear resistance, tough inner core for high strength.

2. PIN LINKS. In Morse Double Pitch Chains, heavy press fit holds pins immobile in pin link plates. Accuracy of assembly and close fit tolerance of pin and plate components assure proper clearances between pins and bushings.

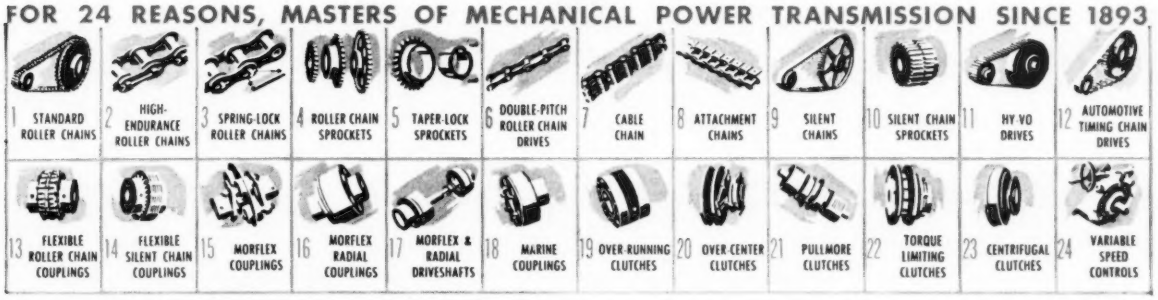
3. BUSHINGS. Morse bushings are case hardened and heat treated for maximum wear. Smooth inner bearing surfaces and true roundness help eliminate pin scoring, increase joint life, reduce elongation.

4. ROLLERS. Rollers, processed from special alloy steel, are shot-peened for maximum wear and resistance to shock.

5. LINK PLATES. Morse link plates are specially treated to obtain maximum structural strength and maximum endurance qualities necessary in highly stressed tension parts.

If you'd like sound, effective engineering help on drive design, attachment selection, or any related mechanical-power-transmission problem that's bothering you, let us put you in touch with one of our skilled Morse Men. Or, write for Catalog C52-52. MORSE CHAIN COMPANY, 7601 Central Avenue, Detroit 10, Michigan.

FOR 24 REASONS, MASTERS OF MECHANICAL POWER TRANSMISSION SINCE 1893



Double Cog-Belt* Surpasses Tests

on New Minneapolis-Moline All-purpose Uni-Farmor

Minneapolis-Moline Equips New Uni-Farmor with Dayton Double Cog-Belt after extensive tests

The technological trend toward accomplishing a multitude of farm chores with a single source of mobile power created the need for the development of a traction belt drive of greater horsepower capacity and range of speeds.

This Uni-Farmor, for example, designed and built with a Uni-Tractor as the basic carrier, employs a series of belt powered attachments to perform any desired harvesting job. With the Uni-Farmor a farmer can pick and husk corn in the morning and combine soy beans in the afternoon by merely switching quick-change attachments to fit the projects planned for the day.

The attachments, being operated by belt power transmitted from a heavy transmission drive on the Uni-Tractor through a countershaft, require a belt of great flexibility and strength. For such heavy duty application only a drive of unusual tenacity, great transverse rigidity and tremendous durability could perform to complete satisfaction.

In the developmental stage it was soon learned that drive belts lacking these characteristics invited excessive breakage, lowered operating efficiency. Costs, too, were increased as the necessary replacement factor mounted. Extensive tests were made by Minneapolis-Moline with almost every type of conventional drive . . . but the problem remained.

Then Dayton Agricultural Engineers suggested Dayton Double Cog-Belts as the answer. Tests were made under the most gruelling conditions of ground and grade variations with amazing results. Dayton Double-Cogs outlasted all other drive belts in the test!

Photo Courtesy of Minneapolis-Moline

*T. M.

This is a typical example of how Dayton Agricultural Engineers lend assistance to farm implement manufacturers in the solution of their problems. Possibly you are in need of like assistance . . . it's yours for the asking. Just write, wire, or call, and all the resources of Dayton's Agricultural Division will be at your service without any obligation whatsoever.

Mr. Martin Ronning,
Chief Engineer, Minneapolis-Moline

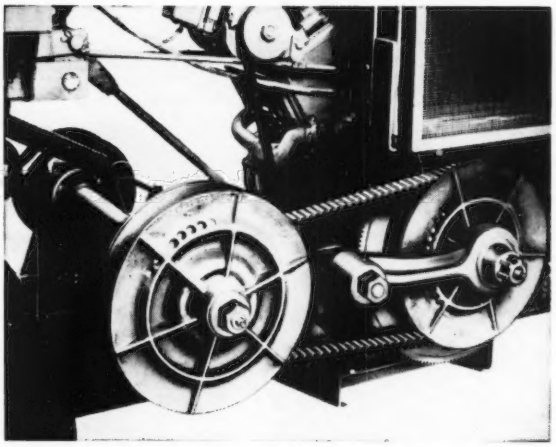
"Dayton Double Cogs Stand Up . . ."

Mr. Martin Ronning, Chief Engineer, Power Machinery Division of Minneapolis-Moline and winner of the Modern Designs Award from Design News for design and development of the Uni-Farmor has this to say about Dayton Cogs: "Our field tests revealed that Dayton Double Cog-Belts stand up far longer . . . best performance we've ever seen."

Designed for Flexibility with Strength

Designed for trouble-free, long-lasting service, the Dayton Double Cog-Belt readily meets all tests for flexibility and strength. The molded cogs both top and bottom, and the Stiflex fibres in the rubber compound offer great transverse rigidity. A thin, tough, neutral axis permits easy bending around drives and pulleys and reduces weight. Dayton Double Cog design sets up fewer internal stresses and strains and offers greater radiant surface to dissipate heat, thus increasing the ability of the Dayton Double Cog-Belt to withstand severe use under all conditions.

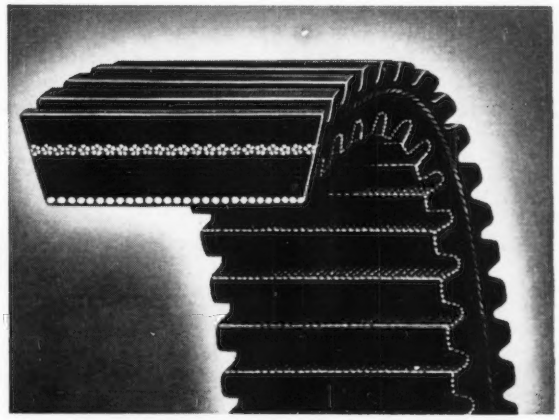
For additional information on how Dayton V-Belts can improve your original equipment, write direct to: Dayton Rubber Company, Agricultural Division, Dept. 402, 1500 S. Western Avenue, Chicago, Illinois.



Close-up shows Uni-Farmor heavy duty transmission drive using Dayton Double Cog-Belt for power transmission.

Dayton Double Cog-Belt lasts far longer in actual operation

The heavy-duty transmission drive has a large capacity Dayton Double Cog-Belt on the countershaft pulley opposite the variable speed drive sheave to transmit dependable, continuous power to the transmission countershaft. Test-proved Dayton Belts lasted longer than ordinary belts in this heavy-duty application.

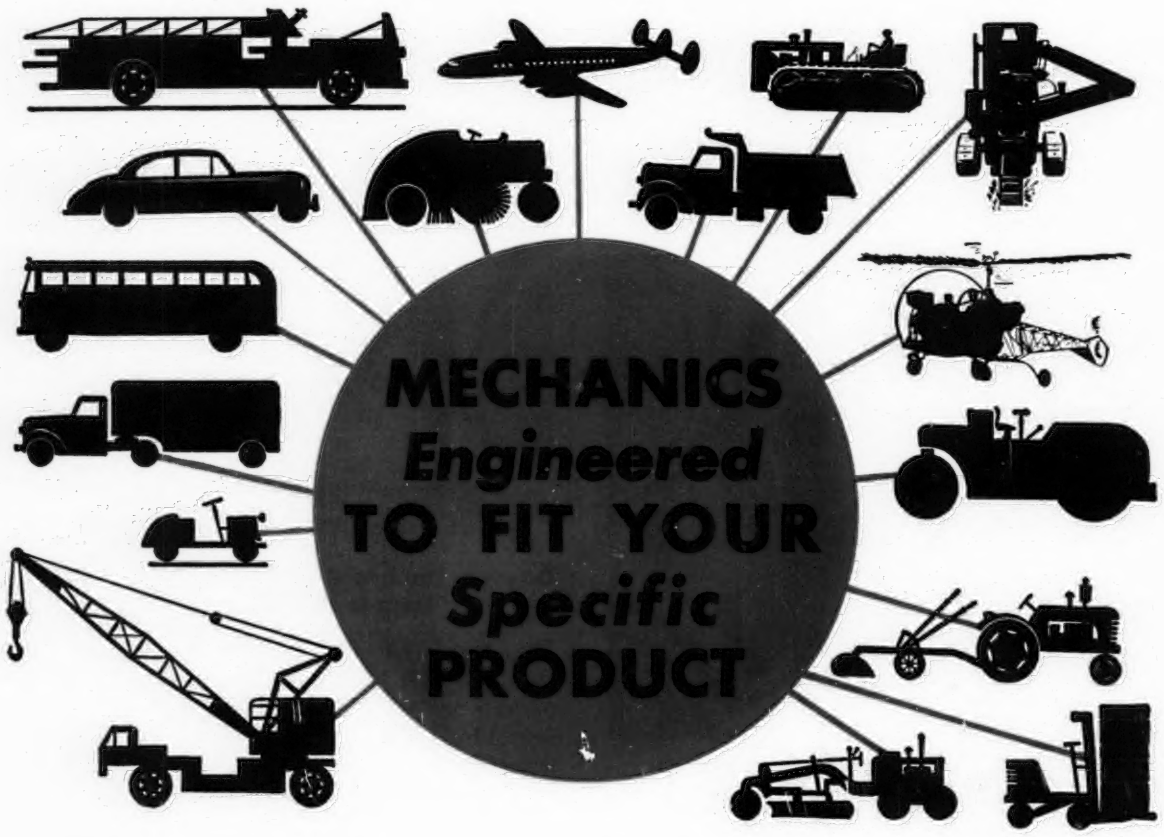


Dayton Double Cog-Belt construction offers maximum flexibility and strength under severest tests.

©D. R. 1954

Dayton Rubber
Since 1905

Agricultural Sales Engineers in Chicago, Moline, New York, San Francisco, Cincinnati and St. Louis



YOU can't expect the engine in your product to deliver maximum power to the wheels — unless the drive line is specifically suited to the operating characteristics of your product.

MECHANICS Roller Bearing UNIVERSAL JOINTS and PROPELLER SHAFTS are factory, field and road tested for torque, overload, shock, angle, alignment, balance, speed changes, reversals and stamina.

Regardless of the type and size of your product, MECHANICS makes joints and propeller shafts that will meet its power transmission needs exactly.

Whatever your drive line problem may be, MECHANICS engineers are prepared with the experience and facilities to help solve it.

MECHANICS UNIVERSAL JOINT DIVISION
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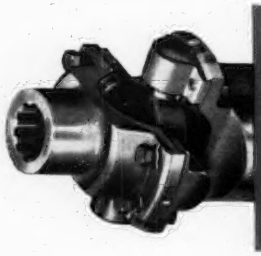

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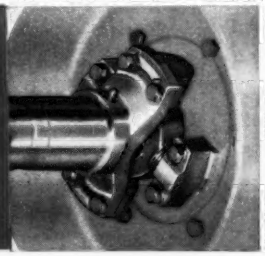

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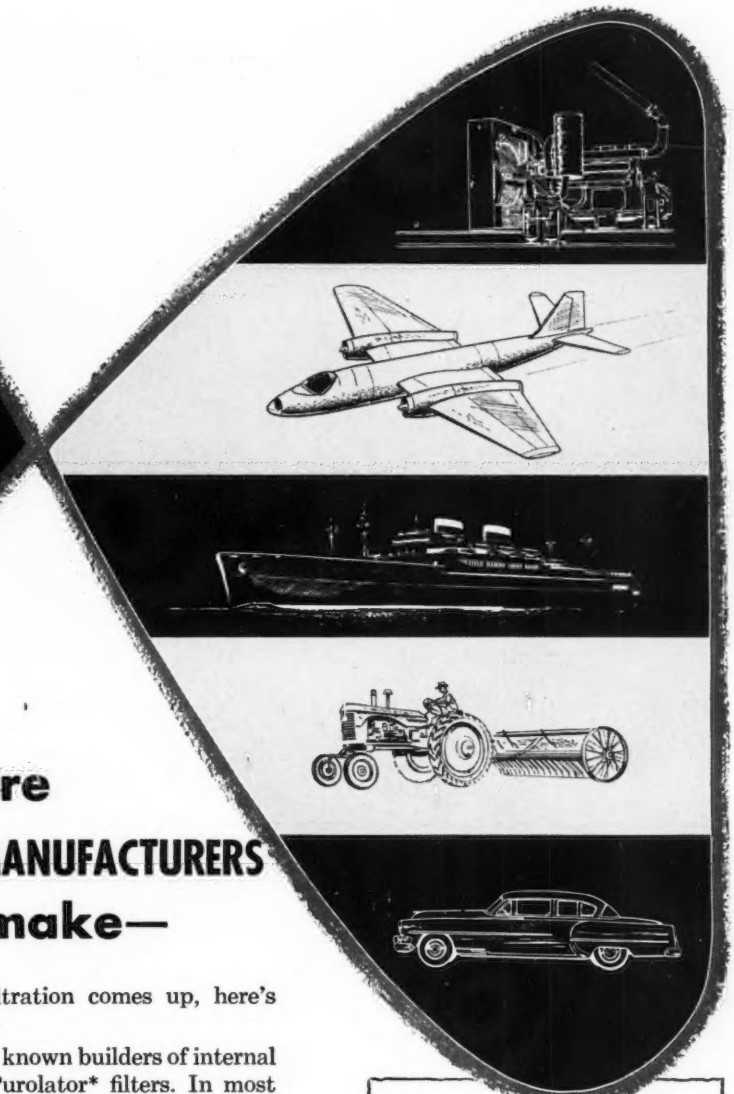

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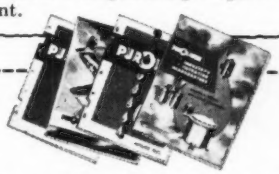

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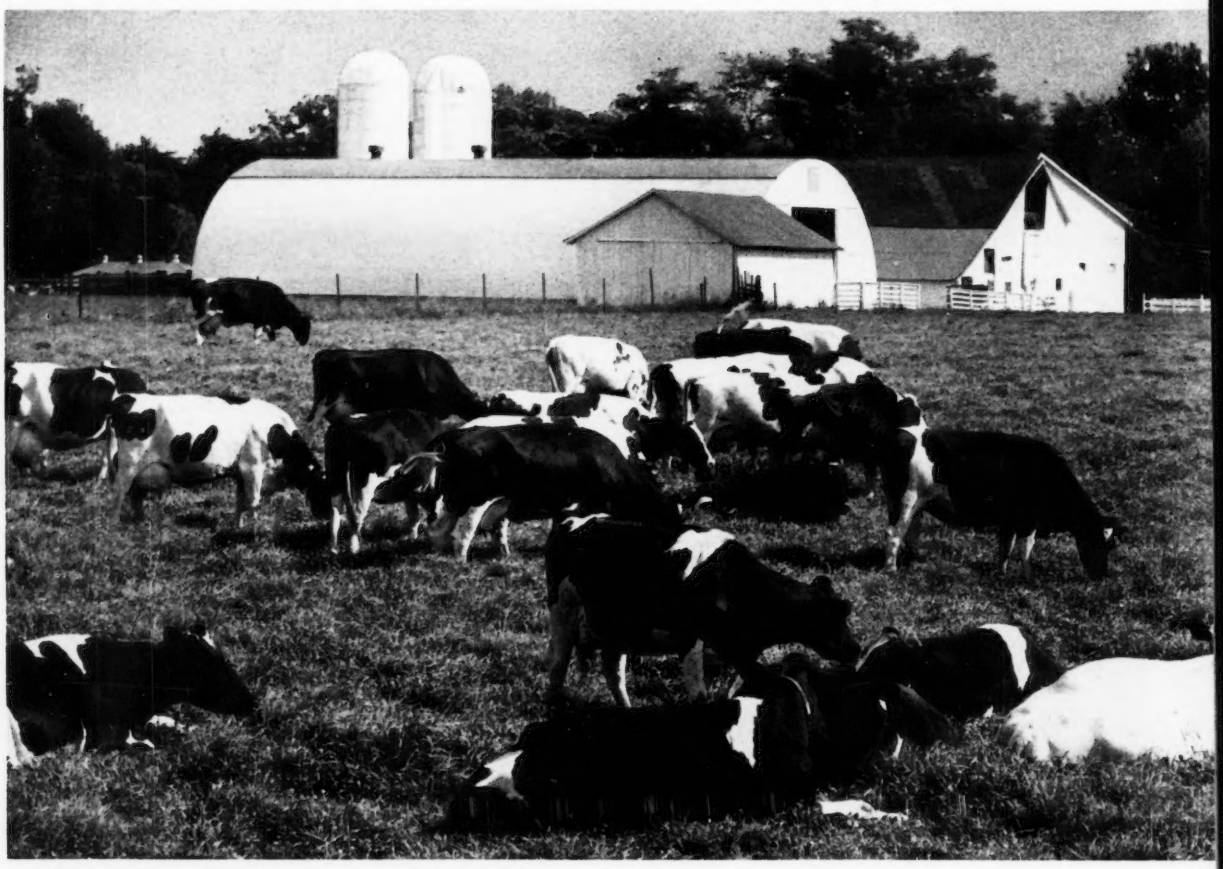
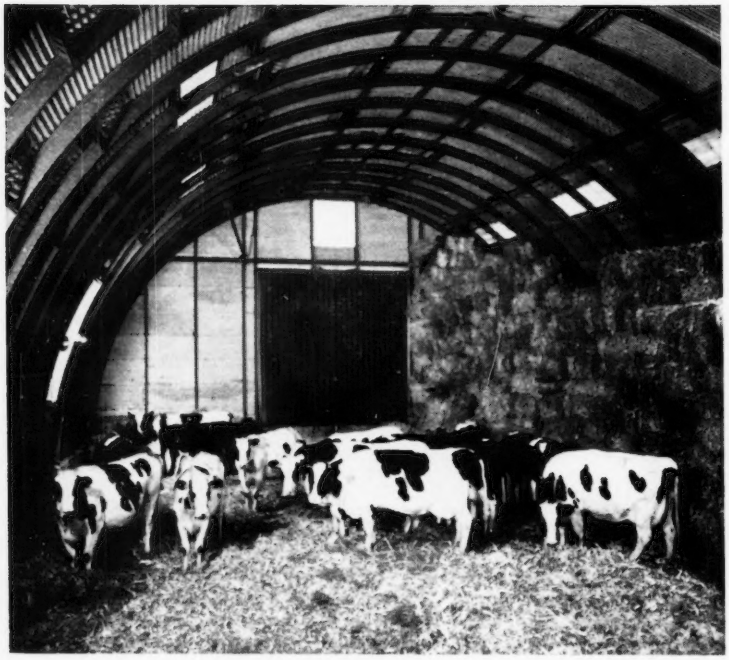
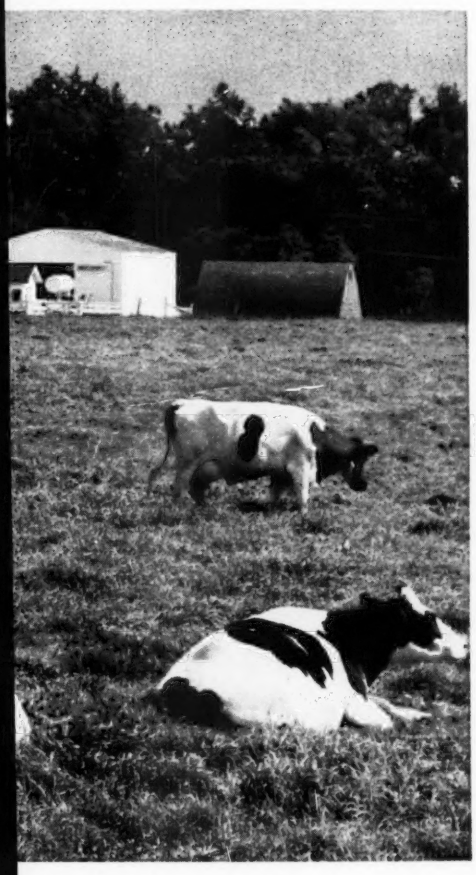




This Quonset 40 by 100 loose housing barn is the key to Fisher's labor problems. He stores a year's bedding and some hay on one side of the barn, feeds the hay in bunks just outside the barn and cleans out the manure pack once a year. "I haven't had a single case of mastitis since I went to loose housing," Fisher says. "And before I was the vet's best customer." And he finds it easy to get the manure pack out of the post-free Quonset interior with little labor.

Walt Fisher's top cow is a 604-pounder. Five heifers in his herd passed the 500-pound mark this year. To make the team they have to hit 450 pounds or more in the first two lactation periods or out they go. To get production on this level Walt uses lines of his own choosing in an artificial breeding program, bolstered by use of his own bull when he can't get the lines

This Quonset 16, equipped with a drying fan and tunnel, lets Fisher store and dry his soybeans, wheat, oats or corn without worrying about loss of any of the grain from moisture. He's looking at some of the 1,500 bushels of wheat harvested this year, now under seal at support price. He parks tractors in the building when it's empty



Management means more milk

Good management boosted the DHIA average of this 35-cow herd 113 pounds in one year. Here's how the owner went about it.

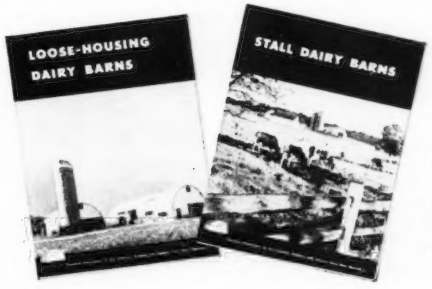
Walt Fisher's milking 35 registered Holsteins on his 340-acre farm at Muncie, Ind., plans to go to 50 soon. Last year his DHIA average was 374 pounds, this year 487 pounds. Here's why.

He's owned the farm for seven years, decided three years ago it could make money. He built up his land to produce more feed, built up his herd to produce more milk and then he added to his buildings to cut his labor requirements.

He's got a 7-year rotation, feeds 213 tons of grass silage, 75-80 tons of hay a year. He raises 60 acres of corn a year, some soybeans, and some oats or wheat. He covers 30 acres a year with manure, fertilizes his pasture seedings with 500 pounds of 3-12-12 fertilizer. He switched to a loose-housing system last year to cut his labor, uses his old barn for hay storage and a milking parlor. He's shooting for a 500-pound herd average and it looks like he'll make it.

he wants. He uses 8 lbs. alfalfa, 4 lbs. brome, 2 lbs. timothy and half a pound of ladino in his pasture seedings. He considers manure second in importance to milk as a crop, side dresses his oats or wheat with liberal nitrogen to produce more straw for his manure pack. This year Walt got 40-bushel wheat from his 35-acre planting, and his 60 acres of corn went about 80 bushels.

Fisher figures his Quonset 24 machinery storage building and shop is one of the "workingest" buildings he has. He cuts depreciation loss on his machinery, gets all of it ready to go during the winter and saves valuable time during his busy seasons because he has fewer breakdowns.



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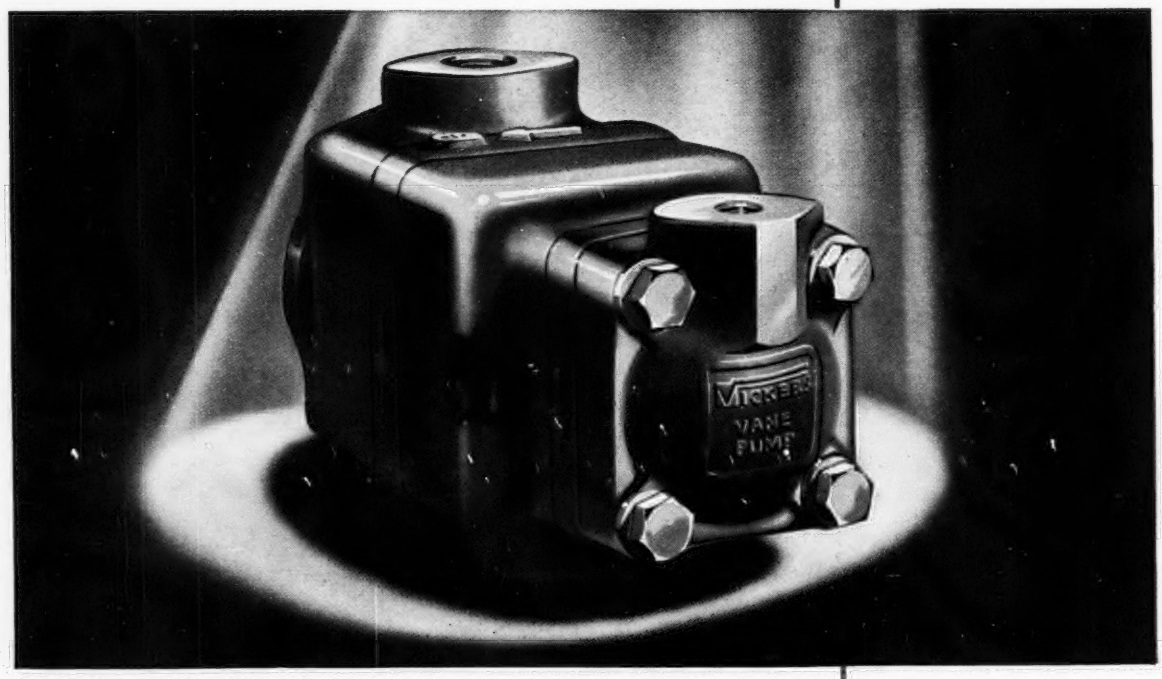

Certain names and designations have become synonymous with long-established quality in consumer products. Some that you will recognize are Sterling, Sheffield, Wedgwood, etc. Similarly, certain names signify long-established quality in industrial products . . . you can think of many with little difficulty.

Among the latter is VICKERS, . . . for long-established quality in Hydraulics. For more than a quarter century, the mark VICKERS, has signified superior products and services . . . with continuous pioneering in hydraulics research and development. As a result, the list of leading manufacturers who use Vickers Hydraulics continues to grow. You also can get the benefits of this dependable, long-established quality by specifying Vickers Oil Hydraulic Equipment.

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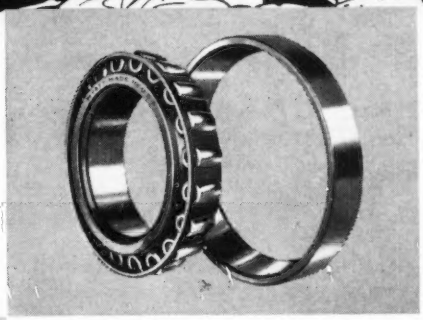

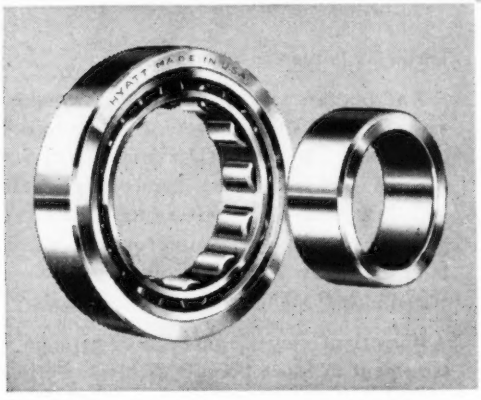

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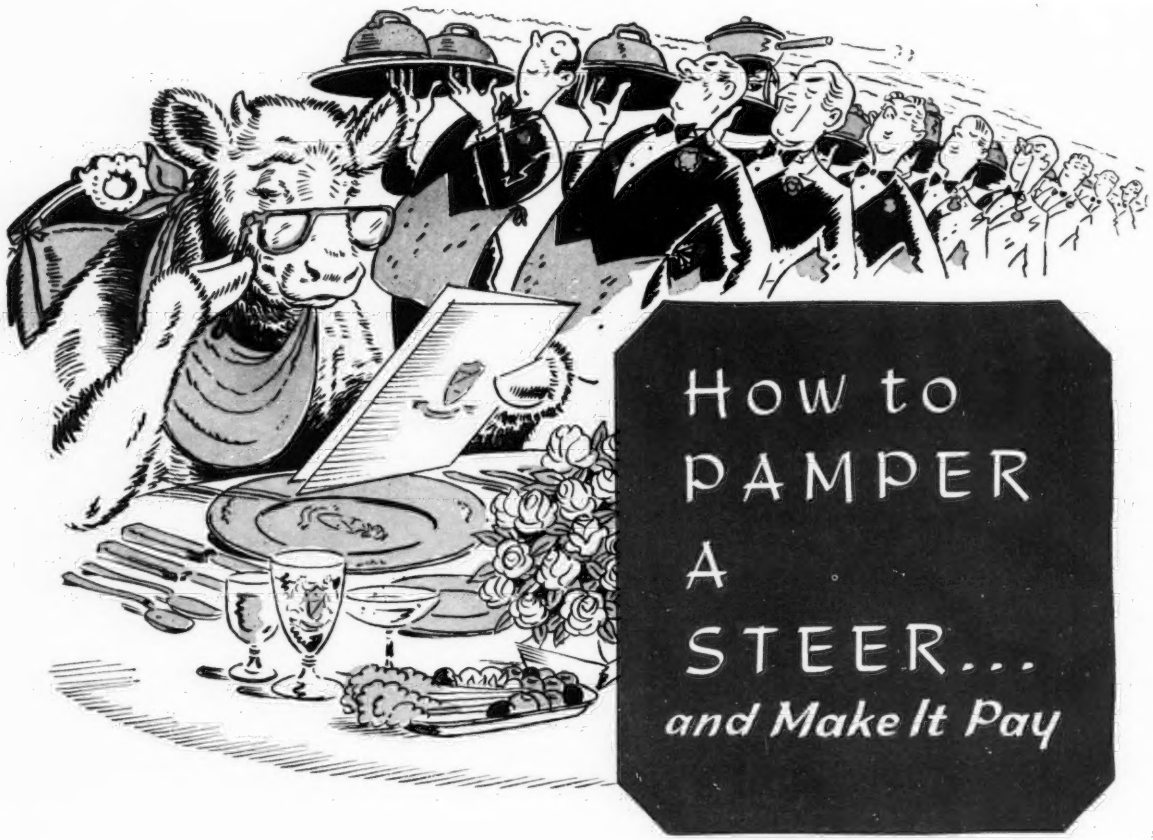

MAYBE it's true that Buster here doesn't know *table d'hote* from *a la carte,* but don't let that fool you. He really knows his "vittles," as anyone who has tossed a shank over a pasture fence can tell you.

Fact is, in his own four-footed world Buster ranks as quite the *gourmet,* and he's been known to get downright fussy at times. That's why those who know him best—cattlemen, that is—have come up with some pretty tasty recipes to satisfy his boyish appetite—to help him grow into a stout, healthy young fellow that will make a good impression on "graduation day," when Buster is shrewdly judged in terms of steak.

And because feeding Buster has become such a science, often special machinery is required—like the new John Deere Grassland Drill, which is making such a hit with livestock growers. You see, the John Deere Grassland Drill makes it possible to establish and improve range and grassland and keep Buster supplied with the wholesome, nutritious food he likes and needs.

Buster, of course, generously pays back such treatment in more pounds of better beef—all because he doesn't have to take the "potluck" fare of poor pasture.

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AGRICULTURAL ENGINEERING

VOL. 35 MARCH, 1954 NO. 3

Design and Development of a High-Speed Mower

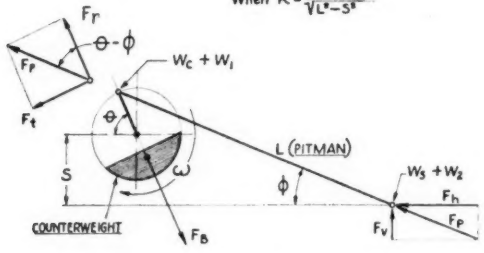
L. E. Elfes

IT IS generally agreed that the agricultural mower has lagged behind the development of the other haying implements. The conventional pitman-type tractor-drawn mower is essentially a slightly improved version of the old horse-drawn mower. True, the bearings in the main drive have been improved, in most cases anti-friction bearings being substituted for the older plain bushings. But the basic arrangement of the drive, the knife head, and the pitman have remained unchanged, except that they are driven from the tractor power-take-off shaft instead of by a ground wheel.

The basic fault of the pitman-type mower is the unbalanced inertia forces set up by the reciprocating knife. The addition of a counterweight to the driving crank reduces the peak magnitude of the unbalanced forces at the ends of the stroke, but increases the unbalanced forces over the mid-portion of the stroke. The usual compromise is to make the mass of the counterweight approximately one-half (or slightly less) of that required to completely balance the maximum knife inertia force which occurs at the ends of the stroke (1)*. A schematic sketch of these forces is shown in Fig. 1.

$$F_h = \frac{W_s + W_2}{g} R\omega^2 \left(\cos\theta + \frac{KS}{R} \sin\theta - K \cos 2\theta\right) \text{ APPROX.}$$

$$\text{When } K = \frac{R}{\sqrt{L^2 - S^2}}$$



$$F_B = \frac{W_c + W_i}{g} R\omega^2 + \frac{I}{2} F_r \text{ (MAX)}$$

Fig. 1 Schematic sketch of inertia forces in the Pitman-type mower

The demand from the field is for a mower which will mow more acres per hour with less maintenance than is presently required. The only ways in which output can be increased with a reciprocating single-knife mower are:

- Increase the cutter bar length beyond the present maximum of 7 ft.
- Higher knife speeds, since, in order to avoid a ragged and uneven stubble, the forward travel of the tractor per stroke of the knife should be maintained at the current average of 3 in, or less if possible (2).

The first solution does not appear feasible because of the structural problems involved in securing an adequately stiff cutter bar. The standard section in current use is not really adequate for a 7-ft bar; and, since the stiffness varies inversely as the cube of the length, an 8-ft bar would be only 67.7 percent as stiff while representing only a 15 percent increase in capacity. Also, the static bending stress at the root of the cutter bar would be 40 percent greater, or about 47,500 psi.

The second possibility practically rules out the pitman-type mower, since the inertia forces and consequently the unbalance increase as the square of the knife speed. Any worthwhile increase in knife speeds over present practice would result in an intolerable increase in vibration and premature failure of many of the drive components.

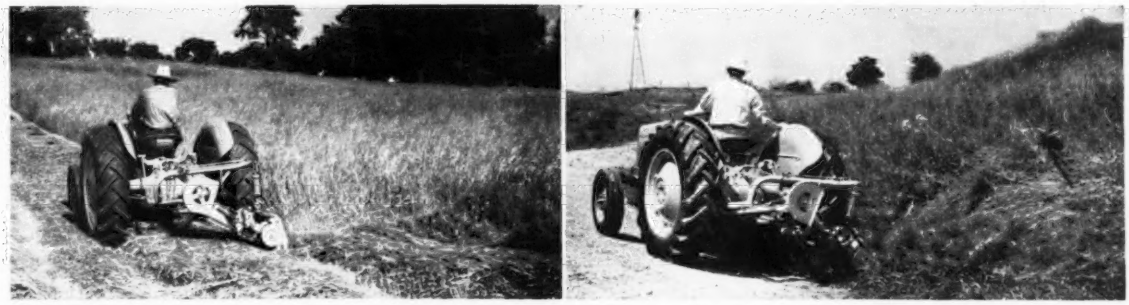
Our conclusion was that only an entirely new type of drive would suffice, and with this in mind the following objectives were established:

- The drive unit should permit continuous operation at knife speeds higher than those of conventional mowers in order to utilize higher tractor forward speeds with a consequent increase in acres mowed per hour.

This paper was presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1953, as a contribution of the Power and Machinery Division.

The author—L. E. ELFES—is project engineer of Harry Ferguson, Inc.

*Numbers in parentheses refer to the appended references.



(Left) The Ferguson dynabalance-drive mower cutting a field of mixed hay • *(Right)* The Ferguson mower cutting along a steep bank

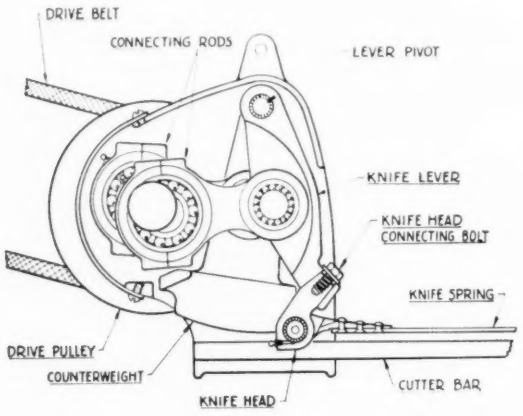


Fig. 2 A schematic sketch of the mower drive unit

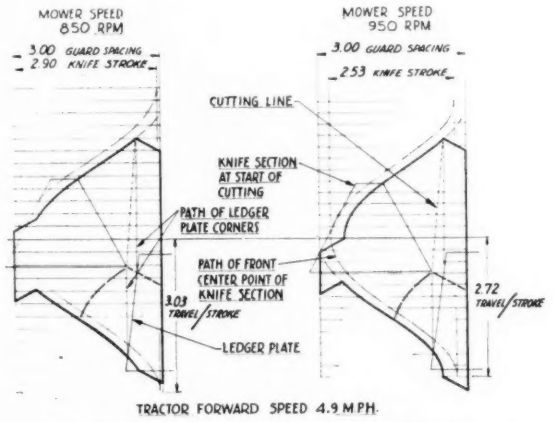


Fig. 3 Cutting graphs for a conventional 3-in-stroke and a 2½-in-stroke mower

- The unbalanced forces at the drive should be held to a minimum in order to reduce the destructive effect on the remainder of the frame and the vibration transmitted to the tractor and its operator.
- The noise level of the machine when cutting should be low so as to minimize operator fatigue.
- The drive unit should be so mounted and driven that the angular position of the cutter bar would not affect its operation.

Reference to the patent literature and other sources shows that many suggestions have been advanced to meet some or all of the requirements listed above. In general, they can be reduced to the following classifications.

- The addition to the reciprocating knife mower of some practical means for balancing out the major portion of the inertia force of the knife.
- A double-knife reciprocating mower in which the second knife is used to balance the inertia forces of the first. This of course is merely a special case of the above classification.
- The elimination of the reciprocating knife and its replacement by an endless chain or band with suitably spaced cutting knives. (A variation on the chain or band saw idea.)
- A rotary mower of the type now familiar as a small power-driven lawn mower, or in the agricultural field as a brush-and-weed cutter.
- The reel-type mower similar to the standard variety of lawn mower.

Several of these possibilities can readily be eliminated because of their obvious disadvantages.

The rotary-type mower requires considerably more power than a device which cuts each stalk only once, and its characteristic of chopping the hay into short lengths does not make it specially suitable for use in harvesting hay which is subsequently to be baled. It has, however, been utilized as the cutting element on at least one forage harvester.

The reel-type mower does not cut tall hay or grass satisfactorily unless its diameter is very great.

The chain-type mower, while it has been the subject of considerable experimental work, suffers from a tendency to plug or jam when cutting fine, tough grass. Apparently the constant direction of motion between the cutting edges is responsible for this fault. Also, at least in the better known designs, the replacement of an entire cutting unit when it becomes dull is a time-consuming job.

The double-knife mower has also undergone considerable development work. It presents the problem of providing suitable guards to protect the knives, while still not interfering with the cutting action.

The final decision was that the present single-knife mower with the addition of a balancing device represented the most promising line of attack.

Several types of drives were designed and tested before an entirely satisfactory version was achieved. The present unit consists of a two-throw crankshaft driven from the tractor power take-off by a V belt and supported in a housing by ball bearings at each end. One throw of the crankshaft drives, by means of a connecting rod, the knife lever which oscillates about its upper end on a pivot pin supported in the housing. The lower end of the knife lever is connected to the knife. The second throw of the crankshaft drives a counterweight communicating to it a motion which is geometrically similar but opposite in sense to that of the knife. A schematic sketch of the drive is shown in Fig. 2.

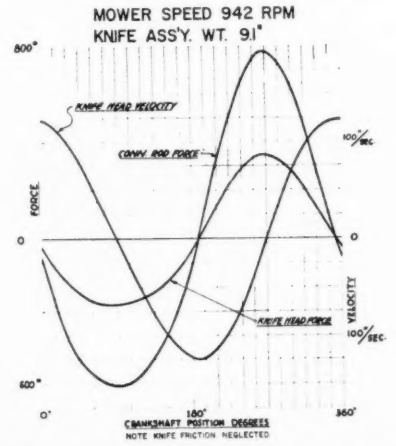


Fig. 4 Graph showing theoretical inertia forces on mower drive unit

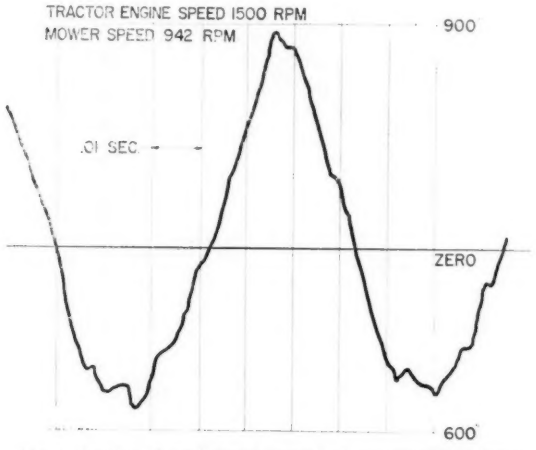


Fig. 5 Section of oscillograph record of connecting-rod forces (inertia only)

The object of course is a substantial reduction in the unbalanced inertia forces, with reduced vibration, which permits higher knife speeds.

The detail design of the drive represented, as is usual, many compromises. The initial problem was the determination of the geometry of the drive and the subsequent analysis of the forces and motions of the drive in order to properly proportion the components.

An analysis of the cutting action of the knife, as compared with that of a conventional mower, indicated that a knife stroke of 2½ in with a guard spacing of 3 in would provide a satisfactory cut without an uneven stubble and without requiring the hay to be deflected forward by an excessive amount. The comparative knife paths for this mower and a conventional mower are shown in Fig. 3.

The shorter stroke is important because it permits:

- A smaller crankshaft throw with the same ratio of crankshaft throw to knife travel
- The smaller crankshaft throw permits the use of smaller bore bearings with consequent reduction in bearing OD and connecting rod size and a smaller housing.

In analyzing the motion of the knife in order to determine the optimum size of the counterweight, the assumption was made that the angular velocity of the crankshaft could be considered constant. The velocity curve of the knife was then determined by means of a graphical analysis, using the method of instantaneous centers. The resulting velocity curve was differentiated grapically to determine the acceleration curve.

An analytical solution would also have been possible, but it was found to be rather time-consuming. The velocity and force curves due solely to the inertia forces on the knife for a mower speed of 942 rpm are shown in Fig. 4, together with the resultant forces in the knife-lever connecting rod. Note that knife friction was ignored.

Subsequent to the construction of the first drive unit, an experimental determination of the connecting rod forces was made by means of SR-4 strain gages mounted directly to the connecting rod. A section of an oscillograph record for the same speed as the computed values is reproduced in Fig. 5. The agreement between the theoretical and measured forces is reasonably good, especially if an empirical knife friction force is introduced.

Having determined the inertia force due to the reciprocation of the knife mass, the counterweight was proportioned so that it would provide an approximately equal counteracting force. In addition to providing an equal but opposite force, it was desired that the line of action of the balancing force be as nearly as possible in the same plane as the knife inertia force in both the fore-and-aft direction and in the vertical plane.

This is, of course, desirable in order to reduce the magnitude of the resultant unbalanced couple. This was achieved by getting the centroid of the counterweight mass as low to the knife as possible and by making the counterweight in the form of a U surrounding the knife lever. In order to facilitate manufacture and service, a compromise counterweight was selected intermediate in size between that desired for the 6-ft and 7-ft knife assemblies. From a practical standpoint, the effect of mower vibration was insignificant.

Anti-friction bearings were selected for all points in the drive unit because of the fact that they permit much closer fits and require far less frequent lubrication. The oscillating joints at the knife lever and counterweight pivot points and at the knife head connection are equipped with needle bearings. The reason for this choice is obvious — low first cost, minimum space requirements, high radial bearing capacity. The balance of the bearings in the unit are all specially designed and built ball bearings with integral synthetic rubber garter spring-type grease seals and provision for the introduction of additional lubricant.

Initially, standard commercial sealed ball bearings with the conventional felt seals were tested. Field tests indicated

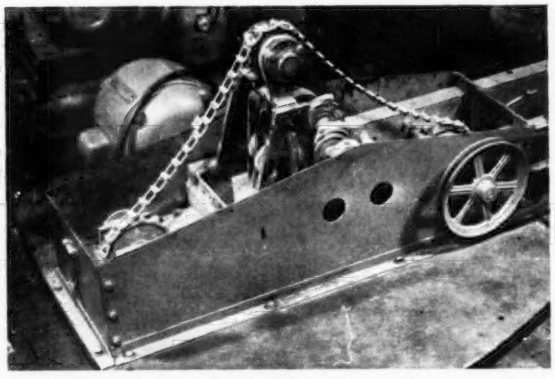


Fig. 6 A mechanically agitated dust box for testing bearings and seals

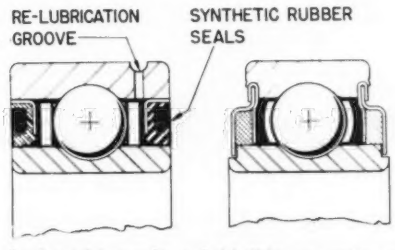


Fig. 7 *(Left)* Special integrally sealed ball bearing with provision for relubrication • *(Right)* Conventional felt-seal prelubricated ball bearing

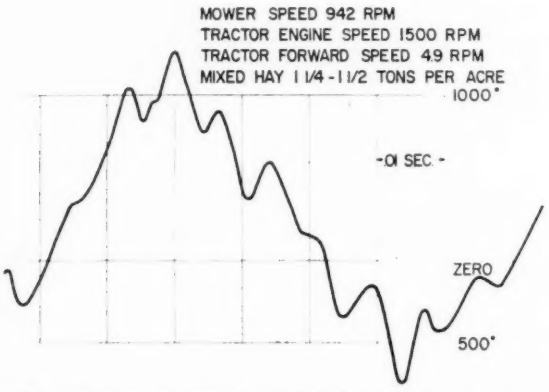


Fig. 8 Section of oscillograph record of connecting rod forces (cutting hay)

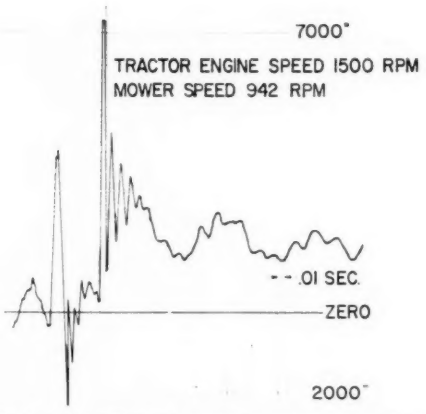


Fig. 9 Section of oscillograph record of connecting rod forces when ⅜-in-diam rod is suddenly jammed in the knife

that these bearings were not satisfactory. A number of failures occurred after relatively few hours of service. Examination of the failed bearings indicated that the grease had been lost from the bearing or badly contaminated by dust. In order to accelerate the development program, three laboratory test fixtures were built to test bearings and seals under load and exposed to three different types of atmospheric conditions:

- Clean, dry, dust-free air
- A constant spray of water
- A mechanically agitated dust box.

The general arrangement of the last fixture is shown in Fig. 6. The other fixtures were similar in construction except for the different devices used to produce the desired exposure condition. It will be noted that the bearing loads were imposed by utilizing the inertia of masses equivalent to that of the mower-knife assembly. The speed of operation and the geometry of the drive exactly duplicated that of the drive units.

These tests enormously accelerated the evaluation of various bearings and seal combinations, but in all cases samples of the bearings were also checked under actual field conditions in order to insure that the accelerated conditions of dirt and water exposure used did not change the relative order of merit of the different designs.

The first listed test fixture was used solely as a check on the ability of the bearings to withstand the expected loads. A B-10 life of 500 hr was arbitrarily established as a criterion of satisfactory performance, and an attempt was made to test sufficient samples so that no serious error would arise due to the well-known dispersion in the life of supposedly identical bearings.

This portion of the test disclosed that the bearing at the small end of the connecting rod presented a problem of "fretting corrosion" or "friction oxidation" between the balls and raceways due to the relatively small angle of oscillation. This was overcome by the development of a special bearing with a full complement of relatively small balls (3). A needle bearing was considered for this location because of its favorable characteristics under oscillating operation, but this type of bearing is quite sensitive to misalignment, and operating deflections resulted in early failure of several test bearings, despite the fact that their radial capacity was several times that of the ball bearings.

The water and dust fixtures showed an altogether different picture. The conventional felt-seal ball bearings had a life expectancy of only 15 to 30 hr when exposed to water spray, and only 30 to 50 hr in the dust fixture. The conclusions were as follows:

- None of the then available "sealed-for-life" ball bearings would stand up for a satisfactory length of time under extremely dusty service without auxiliary protection.
- The length of service obtainable from sealed bearings is a function of *(a)* severity of operating conditions (dust or moisture), *(b)* effectiveness of seals, *(c)* amount of initial grease change, and *(d)* operating temperature of bearing.
- Any felt-seal bearing has a short life when exposed to moisture unless provision is made for relubrication to replace the grease lost by emulsification with the water which passes through the seal.
- The most satisfactory arrangement proved to be, both in the laboratory and in the field, a bearing with a thin-section synthetic rubber oil seal pressed into the outer race and sealing on the inner race plus provision for the introduction of grease through either the inner or outer race.
- Where operating temperatures are high, the life of a sealed bearing is often limited by failure due to oxidation of the initial grease charge (4).

Bearings made to the specifications outlined under appended reference (4) showed a life in the dust box in excess of 200 hr and 350 to 500 hr in the water spray with relubrication intervals of 40 hr. These were accelerated tests, and field tests indicated a life in excess of 500 hr.

Fig. 7 shows a cross section through a conventional felt-seal bearing, and the special bearing now used in the drive unit.

It will be noted that the bearings were selected and the laboratory test work was all carried out on the basis of inertia loads only. In order to justify this assumption, some measurements of actual cutting forces were made using the strain-gage setup previously referred to. A section of the oscillograph record of a run mowing moderately heavy mixed hay (1¼ to 1½ tons per acre) in third gear (4.8 mph) with a

7-ft cutter bar is reproduced in Fig. 8. Reference to the previous record of the inertia forces at the same mower speed shows the following comparison; also, the peak values are shown for the maximum mower speed:

	Tractor engine, rpm	Knife speed, rpm	Avg. max. conn. rod load, lbs	Equiv. knife load, lbs	PTO hp (avg.)
Inertia force	1500	942	920	410	1.70
	2000	1255	1420	605	2.75
Cutting load	1500	942	1280	570	2.55
Plus inertia load	2000	1255	1760	780	3.41

The difference in cutting and inertia load peaks measured at the connecting rod is 350 lb. Percentagewise, at maximum operating speed it is only approximately 1760/1420=1.24, or about 24 percent larger. A speed increase of only 12 percent will produce the same relative increase in inertia forces since the inertia forces vary as the square of the speed. The laboratory tests were carried out at a speed equivalent to that resulting from the maximum no-load governed speed obtainable with the tractor. At the speed (1350 rpm) the inertia forces are equivalent to a connecting rod load of 1550 to 1600 lb.

It would be foolhardy, of course, that this relatively minor effect of the cutting loads holds true for all crop and operating conditions, since the investigation of operating loads has been limited to only one field condition. However, it is felt that the results are typical of a large percentage of the hay cut in this country. In fact, several other tests showed a lesser gap between the inertia and cutting forces.

These results are at considerable variance with the cutting forces estimated by other investigators (2) on the basis of an analytical approach. It is felt that further experimental test data will be needed to give an accurate picture of the energy needed for the actual cutting operation.

In addition to the cutting and inertia loads which must be sustained for many millions of cycles, the magnitude of the occasional dynamic loads which occur when a rake tooth, or other foreign object, jams the mower is of interest. An oscillograph trace of the result obtained by inserting a ⅜-diam steel rod in the knife with the tractor engine running at 1500 rpm is shown in Fig. 9.

It indicates a maximum connecting rod load of 7280 lb with an equivalent knife load of 3200 lb. It appears that this load is limited only by the force required to shear the rivets securing the knife section to the knife back. It was assumed that loads of this magnitude would occur infrequently and that, as far as the bearings were concerned, the only concern was that there be no damaging brinelling of the raceways. The data regarding the static non-brinell capacity of needle bearings is available in the manufacturer's catalog, while the ball bearings were checked by the equation (5):

$$\Sigma V_{max} = \frac{8343\, nd^2 \cos B_0}{f_s 3}$$

where n = number of balls

d = diameter of balls

B_0 = initial contact angle

f_s = a parameter obtained from charts in reference text.

All of the bearings in the drive unit have a static non-brinell capacity at least 30 percent in excess of the maximum expected dynamic load.

In addition to the bearings, the balance of the drive components must be capable of withstanding loads of this magnitude with a margin of 25 to 40 percent between the yield strength of the member and maximum expected load.

With the exception of the drive unit, the knife head and its attachment to the knife are probably the most novel and important features of the mower.

The conventional ball joint and coupling used on most agricultural mowers suffers from a considerable number of drawbacks:

- The center of the ball is approximately 2 in above the center line of the knife mass. Therefore, the force in the pitman produces a moment which must be resisted by the knife structure.
- The ball-and-knife head guides are entirely exposed to dirt, and, in abrasive soils, wear is relatively rapid.
- As a result of the rapid wear just mentioned, it is extremely difficult to maintain a precision fit between the ball and its coupling, even though a self-adjusting takeup may be provided.

The first objection cited above is probably the most serious. Not only is there a moment applied to the knife head, but a vertical component of the pitman force resulting from the angularity of the pitman. Fig. 10 shows the forces acting on the knife head. Conventional practice utilizes a forged knife head guided by wear plates at the inner shoe. These wear plates are intended to resist both the applied moment and the vertical forces. Ideally they should be adjusted to have minimum clearance consistent with free operation. However, this ideal is rarely obtained since even changing knives usually results in a new knife head of somewhat different dimensions which is either too tight or too loose. Looseness at this point shows up as noise due to the reversing direction of the loads on the knife head and may also result in failure of the knife back, usually right at the end of the head due to continuous flexing.

In the design of most rear-mounted mowers, an attempt is made to keep the vertical component of the pitman force low by using a long pitman to reduce the angle which it makes with the knife. The highway mower, where a short pitman must be used if the cutter bar is pivoted around the axis of the crankshaft, is a considerably greater offender because of the larger angle between the pitman and knife.

The second point listed above is obvious and needs no comment. The development of looseness at the ball joint (third point above) provides

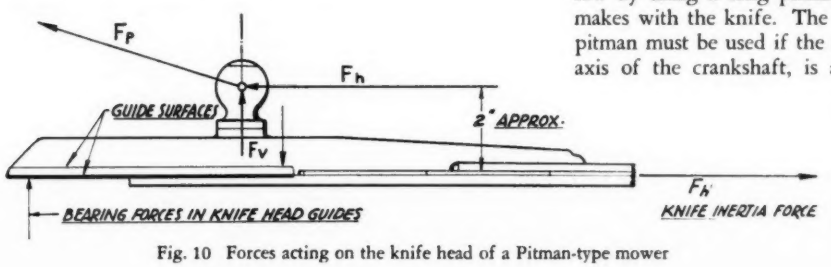


Fig. 10 Forces acting on the knife head of a Pitman-type mower

an additional source of noise and also affects adversely the magnitude of the loads acting on the knife and pitman.

A knife head and connector design was evolved which overcomes the objections to the ball-joint construction, but which of course is only suitable for use with the new drive unit. It consists of an oscillating joint equipped with a needle bearing protected by oil seals and a leaf spring connecting the head to the knife. The center line of the oscillating joint is near the center line of the knife mass; consequently there is no moment transferred to the knife back. The purpose of the spring is to accept the vertical misalignment resulting from the various tolerances plus the curvilinear path due to the pivotal motion of the knife lever about the upper pivot pin (Fig. 2). The knife head is attached to the knife lever by one bolt which secures it in a tapered socket, eliminating all play or looseness in the joint.

The only vertical force applied to the knife is the relatively insignificant amount needed to deflect the leaf spring. Together with the elimination of the moment, this permits the removal of the wear plates, etc, on the knife and the looseness, noise, etc., which they produce. Also, the precision fit at the oscillating needle bearing will be maintained for long periods because it is well protected by synthetic rubber seals.

Besides these advantages, it developed that another benefit resulted from the new knife design. The weight of the knife assembly was reduced from approximately 12.15 lb for the 7-ft conventional knife assembly to 9.15 lb for a 7-ft knife of the new design. Since the knife sections and back are of conventional design, the savings in weight is due entirely to the elimination of the forged knife head, ball, and reinforcement. This represents a 30 percent reduction in the inertia force at the knife head for the same number of strokes per minute since it varies as the first power of the reciprocating mass.

Field experience with the first experimental mower soon showed that the higher tractor speeds made possible by the new drive caused some unanticipated difficulties.

The first of these centered around the cutter bar. Cutter bars are universally made by shearing on a long diagonal cold rolled steel section, which is standard for all manufacturers with a single exception. The analysis is also standardized (SAE 1035-1040) with the result that the physicals are fixed within the range of 80,000 to 90,000 psi yield strength with an ultimate strength of 110,000 to 145,000 psi. Undoubtedly this section was satisfactory years ago for the shorter bars then in use, but it decidedly is not satisfactory for a 7-ft cutter bar on today's mowers. It is too flexible and is subjected to an excessive bending stress. The static bending stress at the root of a 7-ft bar when the outer shoe is lifted clear of the ground is approximately 30,000 psi by computation. Strain-gage investigations show that this stress increases to 75,000 to 85,000 psi when the mower is driven over rough ground at high speed with the cutter bar held horizontal. Laboratory tests of the cutter bar under continuous flexing with a maximum bending stress of 85,000 psi indicate that it has an average life of only 70,000 cycles. In a general way, this is borne out by field experience, which indicates that 300 to 400 hr of use over the irrigation borders in California will result in a failure of the cutter bar.

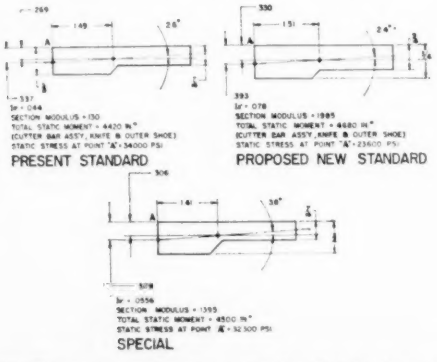


Fig. 11 Dimensions and section properties of cutter-bar sections

The solution which we propose to this difficulty is a new rolled section with a large moment of inertia to increase its stiffness and with an increased section modulus. The suggested section is shown in Fig. 11, together with its section properties for comparison with the present standard and the special section used by one manufacturer.

Inquiries in the field have indicated that many users of mowers are dissatisfied with the lack of rigidity of the cutter bar, at least in the 7-ft length. It is hoped that some agreement can be reached among all mower manufacturers regarding the most desirable modifications to the present section so that only a single new standard need be introduced in the interests of lower cost and more ready availability from the steel mills.

Higher tractor speeds raise still another problem, namely, adequately protecting the machine against damage when striking a hidden obstruction. Since the kinetic energy of the tractor varies as the square of the speed, relatively small increases in speed cause rapid increases in the destructive energy available. When the obstruction is struck somewhere along the outer half of the cutter bar, the safety-release mechanism protects the machine by letting the bar break back far enough to clear. However, if it is located in the inner portion of the bar, there is not sufficient angular travel to let the cutter bar clear, and the impact forces become very high, with considerable likelihood of extensive damage to the machine.

Sections of two oscillograph records of the forces in the mower pull bar are reproduced in Fig. 12. One test was run with the conventional spring breakback, while the second

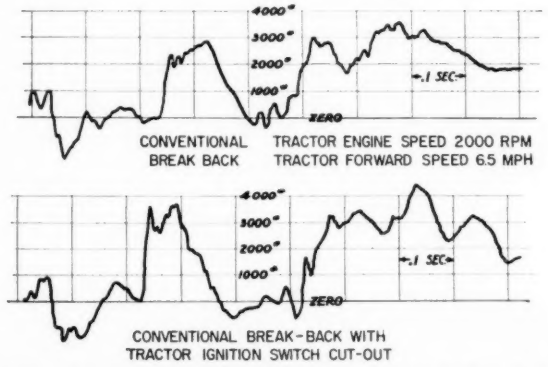


Fig. 12 Oscillograph records of pull-bar forces when inner shoe strikes solid obstruction

run was made with a tractor ignition switch cutout which operated as soon as the mower cutter bar started to break-back. This had no significant effect on the magnitude of the peak forces when the pull bar reached the stop which limits its travel.

To date no practical solution has been found to the problem of absorbing the greater kinetic energy resulting from higher tractor speeds in a manner which will not damage the mower.

The V-belt drive for the drive was originally designed to transmit 3.5 hp, since the best available data indicated that a rough rule of thumb was ½ hp per ft of bar length. The standard C section belts selected had a very limited life, and it was found necessary to adopt a special heavy-duty construction with one of the high-strength low-stretch synthetic fibers. This has provided satisfactory life, but a strain gage torquemeter was used to determine the actual average and peak horsepower requirements of the drive for further information. The recorded torques have been converted to horsepower at the engine test speed of 1500 rpm, and the results are as follows:

	Horsepower	
	Average	Maximum
Inertia	1.70	6.18
Mowing—2nd gear	2.49	6.35
Mowing—3rd gear	2.55	7.00

It will be noted on the oscillograph record of the torquemeter readings (Fig. 13) that the torque peak occurs twice per revolution of the mower drive unit pulley. This is in agreement with the theory. The maximum horsepower values tabulated above were computed from these torque peaks. Also, reference to the previous inertia load data indicates that only 0.6 to 0.8 hp is actually utilized in cutting the hay.

The reason for the difficulty with the original drive belts now becomes clear, for actually the belt must be adequate to handle not the average torque but rather the peaks which occur every cycle.

It is interesting to note that, in the course of the tests conducted to determine the maximum loads to which the drive components were subject (Fig. 9), torques as high as 370 ft-lb were measured at the tractor power take-off by the strain-gage torquemeter. At the known engine speed of 2000 rpm, this is the equivalent of 51.3 hp which presumably is transmitted by the drive belt. This would require a net belt tension of approximately 740 lb, which is well in excess of the installed tension. The reason for this phenomenon is not known, but it casts some doubt on the frequently repeated claim that a V belt constitutes an effective cushion against shock or dynamic loads.

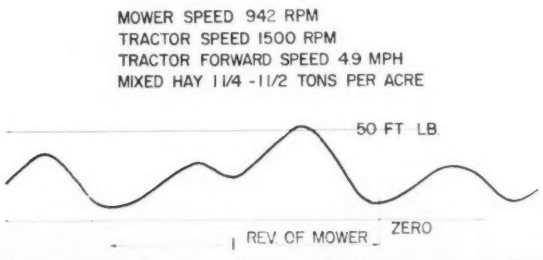

MOWER SPEED 942 RPM
TRACTOR SPEED 1500 RPM
TRACTOR FORWARD SPEED 4.9 MPH
MIXED HAY 1 1/4 - 1 1/2 TONS PER ACRE
50 FT LB
REV. OF MOWER
ZERO

Fig. 13 Section of oscillograph record of PTO torquemeter reading (cutting hay)

The variable torque requirements of the drive cause another unpleasant phenomena by exciting a large amplitude whip in the relatively long belt spans. If it is assumed that the belt is not too stiff to follow the same phenomena as a string, the natural frequency is:

$$f = \frac{t}{p}\sqrt{\frac{l}{2L}}$$

where t = belt tension
p = mass per unit length
l = span

The only feasible remedy for this self-excited whip is to increase the natural frequency of the belt to well above the exciting frequency. This was done by shortening the belt span by adding idlers at the midpoint of the span, and by increasing the operating tension to approximately 200 lb per side. The natural frequency is then 3460 cycles per minute.

The maximum drive-unit speed is 1350 rpm, which means the maximum exciting frequency is 2700 cycles per minute. Since the natural frequency is well above the exciting frequency, it was expected that this change would reduce the amplitude of whip to an acceptable value. Tests indicated that this was the fact.

CONCLUSIONS

The original objectives outlined in the introduction have been met as follows:

- The new drive unit will, it is believed, permit higher continuous knife speeds than any other mower on the market with a corresponding increase in acres mowed per hour.
- The counterweight in the drive unit reduces the unbalanced forces to a negligible value.
- The precision fits at all points in the drive plus the elimination of the conventional knife head and guides have very substantially reduced the noise level of the mower.
- The entire drive unit is supported in trunnions which are concentric with the axis of the drive pulley. There are no restrictions on the angle at which the cutter bar can be operated except those imposed by the lift mechanism and balance spring.

Field experience from the first limited production runs indicates that the new drive has lived up to expectations in all major respects.

There has been no really new development in the agricultural mower field in the last hundred years. It is hoped that this mower will stimulate the entire agricultural engineering profession to a new and fresh approach not only to the design of mowers but farm machinery in general.

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Unified National Electric Fence Code Needed

C. L. Hamilton
Member ASAE

CONTINUOUS background controversy over electric fencing standards and production codes, their application and promotion ethics, has curtailed universal acceptance of approved electric fence controllers. Inadequate research, differing codes and opinions and unwillingness to make concessions provide the fuel that keeps the electric fencing turmoil simmering year after year. This confusion has

- Boycotted clear-cut effective educational programs among farmer users
- Deferred the adoption of any code or corrective legislation in many states
- Deferred general adoption of unified production standards in the industry
- Made it easier for some producers to argue themselves into establishing their own production standards
- Kept many producers in the middle-of-the-road quandry, so they continue producing both approved and unapproved units
- Produced discouraging competition for producers conscientiously striving to maintain recommended standards and market only approved units
- Fostered dissention within the industry and disbandment of any central coordinating organization.

Since the present three electric fence codes (Wisconsin, Underwriters, and Bureau of Standards) were established about 15 years ago, the industry has drifted along by itself. Today well over half the controllers sold to farmers do not meet the standards of either of the two recognized testing agencies. There appears to be a half-hearted acceptance of this situation among many leaders in the field. They are at least reluctant about vigorously supporting any strong, educational campaign against unapproved commercial units. It is time effort was made to pinpoint and correct the reasons for this situation, even though it may mean concessions, code adjustments, production changes, or expenditures for additional research. In the past there has been too much of a tendency for code and education leaders to sit by and blame others for the dilemma.

In the meantime, unnecessary electric fence fatalities and fires continue year after year. Most of these are due to homemade current regulators, but some commercial units are undoubtedly involved also. Each year there are a number of farm fires attributed to unsafe electric fence installations. There are also many livestock electrocutions reported annually. A fence that kills livestock will also kill people. In addition, there is undoubtedly a large number of near tragedies—where a person becomes frozen to a charged fence, but lucky enough to have someone nearby to rescue him before it is too late. The victims are mostly small children who accidentally come in contact with an unsafe fence while playing on damp ground.

This is a prepared statement presented at a conference on national electric fence code problems held at Washington, D.C., January 27, 1954, under the sponsorship of the National Bureau of Standards.

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Even though electric fences present special hazards, they are popular with farmers, and there are hundreds of thousands of them in use. They are inexpensive, simple to erect and easy to move. They fit in well with conservation farming where portable fences are needed for seasonal and rotation grazing. There is no question about their need or economy in livestock production. To satisfy farmers, they must have an effective fence. If approved controllers ever get the reputation of being ineffective, the industry will be confronted with hopeless black market operations. It is impossible to have safety without effectiveness, even with legislation. In this country people usually get what they really need by making it themselves or by bootlegging when there is no legitimate channel to follow.

Surely the technical know-how and production ability to make electric fences both safe and effective is available. If a coordinated attack is launched and honestly supported by everyone, the fog that now plagues the whole industry should soon disappear. The selfish interests of any group or of just a few individuals could continue to boycott progress and make the fog worse.

Points of Confusion. Fortunately, on one point there is agreement — complete elimination of homemade electric hookups. Educational agencies have been making progress in this direction, but there are still many of these deathtraps in use. Unsafe or homemade installations should be prohibited by law with severe penalties for violators. The simplicity of continuous-current controllers tempts young mechanics and amateur electricians to experiment with homemade regulators. An open, clear-cut policy on continuous-current controllers would help make educational work more direct and effective.

This leads to the first major point of confusion in the industry. One of the existing codes permits the use of a continuous-current controller and the others do not. It is manifestly impossible to have a strong educational program and expect results when there is confusion in the minds of the leaders.

Continuous-current controllers are cheaper to build, and they seem to be good sellers because there are many thousands of them in use. If a complete performance record were available, it might not look too serious, but this would not necessarily prove that they are safe controllers. It is well known to many observers that there are many thousands of unsafe electric-wiring installations on farms, yet the accidental electrocution record is surprisingly low. In addition to an exposed electric hazard, it is necessary that the right accidental live and ground contacts be made at the same time. Even then a fatal statistic can be avoided if the victim is rescued or revised through artificial respiration.

The number two confusion in any educational program on electric fencing is identification of "approved controllers." If the farmer is instructed to look for the certification of a testing agency on the manufacturer's nameplate, he frequently finds a certification reading "Built to comply with the National Electric Safety Code." This inscription sounds like an important approval certification to him, and he

(Continued on page 162)

Contemporary British and European Tractors

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Fellow ASAE

FOLLOWING World War II the economy of war-ravaged Europe lay prostrate. Millions of men were dead or disabled, currencies were debased, and in Western Germany alone 700,000 people died of starvation and exposure. Transportation had broken down and factories were either largely destroyed by bombing or filled with machinery worn out by seven years of war production. Of no less significance was the decay of skills necessary to the pursuits of peace. Millions of work animals were either lost as war casualties or slaughtered to provide human food, and the productivity of the soil had seriously deteriorated as the result of forced food production and insufficient fertilizer during the war years. Against this backdrop of horror and anguish, and haunted by the specters of want and hunger, Europe turned to power farming for survival.

The prime concern of governments was that of feeding a hungry people—to establish food production and rebuild soil fertility. As a near-term effort, huge quantities of American-built tractors and power-farming equipment were imported. For the longer term, every effort was directed toward establishing an expanding farm machinery industry, adequate to supply internal needs. Because of the general shortage of power-farming equipment, it had a purchasing power in the world food marts equal to gold. Because of this manufacturers foreign to the farm equipment field turned to tractor production. This resulted in an exportable surplus, which could be used to barter for food and vital raw materials. For example, in the years 1948, 1949, and 1950, England exported 59, 55, and 70 percent respectively, of all wheel tractors manufactured (1)*. During these same years, although numerically more tractors were exported from the United States, the domestic demand was such that exports totaled but 20, 18, and 15 percent of total wheel-tractor production (2).

Thus stimulated by necessity the manufacture of farm machinery in both England and Germany became the fastest growing segment of the capital goods industry. So great has been this growth, and so effectively has it served to increase world production of foodstuffs and vegetable fibers, that recent months have witnessed a serious decline in the prices of American farm products and in the production of American power-farming equipment. Sales of American farm machinery first suffered from the impact of increasing competition in world markets, and today faces the competition of foreign-built tractors in the domestic market.

In all countries the pattern of tractor design is determined primarily by needs of the home market. As a basis of comparison, and for a better understanding of the European scene, a brief consideration of the United States home market is enlightening. High labor costs favor replacement or exchange of parts and even major assemblies, rather than on-the-farm repairs. Our highly developed distributing system and rapid communications make repair parts cheaply and quickly available. Parts likely to require replacement are low in cost and, where possible, light in weight. A long and trouble-free life before major overhaul is necessary is built into American farm machinery. However, long total life, as compared with industrial machinery, is not sought, so that we can better take advantage of technological progress. The enormous size of the automotive industry, of which the tractor industry is directly a part, makes continuous research possible, with designs adapted to the latest requirements of the farmer. There can be little doubt that the power-farming machinery industry of the United States is continuously well adapted to the needs of the home market.

It follows that the needs of many of the world's markets, particularly in the less developed countries, have in some respects been met advantageously by industries largely dependent on exports to these markets and in position to cater to their special requirements. Many trade channels are closed to exports from the United States because of lack of dollar exchange brought about by limitation of imports into this country. This condition is augmented by mounting labor costs and an artificial price structure of foodstuffs resulting from government subsidies. Many articles of American manufacture greatly needed by customers abroad are priced out of world markets. In view of these circumstances, together with the lack of evidence that manufacturers in the United States can produce more cheaply than their best foreign competitors (when equal production volumes are considered), the prospects for the English and European tractor industry in world markets appear promising. The extent to which farm tractors are used throughout the countries of western Europe, other than those behind the Iron Curtain, is shown in Table I. It is interesting to note that the density of tractors in England, Switzerland, and Western Germany is greater than in the United States. Against this background of European farming needs and world markets, the English and European farm equipment industry has taken its present form since the end of World War II. An examination of the organization, methods, and products of European manufacturers will serve to define the nature of competition for world markets.

Until the early 1930's, tractor production in the United Kingdom was limited. Most tractors then in use had been imported from the United States. The first Fordson tractor was imported in 1917 and due to the increasing demand for motor vehicles including tractors, the Ford Motor Company erected a factory at Dagenham, a suburb of London. This plant initiated tractor production in 1933, building 2,788 tractors that year. Production increased until, in 1937, it was at the rate of approximately 18,000 yearly.

In 1934, David Brown, manufacturers of gears and gear-cutting machinery, produced a prototype tractor embodying the Ferguson hydraulic lift. In 1938, David Brown Tractors, Ltd., was formed to exploit the production of tractors of this type. Several other manufacturers started to develop tractors, but during the war years their tractor production

This paper was presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1953, as a contribution of the Power and Machinery Division.

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*Numbers in parentheses refer to the appended references.

was held to an insignificant quantity. In 1946, the Ford Motor Company remained the major tractor builder, with an annual production of 25,000, or 87 percent of the total. In 1947, total British production increased to approximately 58,000 units, or double the number produced the previous year. The proportion of Fordson production dropped to about 60 percent, due to the increased output of all manufacturers, including several new producers. In 1946, the Standard Motor Company started mass production of the Ferguson tractor and in 1948 was manufacturing at the monthly rate of 5,500 units. Ferguson production in 1951 was at the rate of 300 per working day, or 70,000 units annually. There has been a considerable further increase in production capacity. David Brown Tractors, Ltd., which had produced only about 1,000 tractors annually throughout the war years, greatly increased the output of its post-war types. In 1950, they were producing three times as many as in 1948 (1). Present production is reported to be at the yearly rate of approximately 12,000 but is capable of being considerably increased. Marshall of Gainsborough introduced a diesel wheel-type tractor after the war and in 1948 was producing 2,500 yearly. This same firm, in collaboration with the Fowler Company, has developed three models of track-type tractors. Morris Motors, large manufacturer of passenger cars and trucks, introduced the Nuffield tractor and production is estimated at over 5,000 yearly.

Tractor production in England has been increased through the establishment of English factories by a number of American manufacturers including Massey-Harris, Allis-Chalmers, and International Harvester.

It will be seen that the English tractor industry has really taken its present shape since 1948. Production figures are not available, but present production is reportedly in excess of 10,000 units per month. Within the past year, David Brown has brought out a small tractor known as the Model 25, while the Fordson Major tractor has been completely redesigned.

As in the United States, the production of diesel tractors in England has been limited. In 1948, it was only 3 percent of all wheel tractors produced. This increased to 12 percent in 1950 and 16 percent in 1952 (1). A number of factors contributed to this condition:

1 England exports to many markets, such as Sweden and Denmark, where gasoline is as freely available as diesel fuel, and the price differential does not justify the increased cost of diesel engines, especially in the smaller sizes.

2 "Vaporizing oil," equivalent to the United States tractor fuel, is freely available without high excise taxes.

3 The high cost of diesel engines as compared to gasoline engines of equal power is not justified by savings in operating costs.

4 The fuel consumption of the diesel engines used in English wheel tractors is generally high as compared with their American counterparts.

The National Institute of Agricultural Engineering, an agency of the British Government, operates a tractor-testing installation at Wrest Park, Silsoe, Bedfordshire. Tests are conducted by a highly competent staff on an exhaustive and scientific basis. Results are published on a basis comparable with those of the official Nebraska Tests, except that the belt horsepower and torque readings of spark-ignition engines—gasoline and vaporizing oil—are corrected to sea-level, dry-air conditions (60 deg, 29.92 in Hg). Drawbar horsepower readings are not corrected. For diesel engines, no correction is applied to any observed power reading.

Specifications and official performance data of the principal English wheel tractors are shown in Table 2. Composite curves showing the specific fuel consumption of British gasoline, vaporizing oil, and diesel wheel tractors operating on the belt are shown in Figures 1, 2 and 3 in comparison with the performance of the American tractors having the lowest specific fuel consumption. The sources of all data are manufacturers' sales literature, the official test reports of the National Institute of Agricultural Engineering, and official Nebraska reports.

David Brown Tractors, Ltd., manufactures both wheel and track-type tractors. The Model 30C is shown in Fig. 4, the comparison of their narrow-gage and standard-tread tractors is shown in Fig. 5 (3), and the largest track-type tractor is shown in Fig. 6. The present range of David Brown tractors, as distinguished from earlier models officially tested and shown in Table 2, is shown in Table 3.

These tractors form a pattern based on the original conception put into production with the first David Brown tractor in 1939. The following measure of interchangeability is featured: Wheel-tractor Models 25, 30D, and 30C employ the same chassis and transmission, and the same cylinder block as the Model 30TD. Track-type Models 30TD and 50TD use the same chassis as the Model 50D wheel tractor. A similar transmission assembly is used on Models 30TD, 50TD, and 50D. The same wet-cylinder liner is used on all engines except the Model 25.

This measure of interchangeability of parts helps keep

TABLE 1. TRACTORS ON FARMS THROUGHOUT EUROPE (1)
(As of January 1, 1951, unless otherwise indicated)

Country	Arable land Acres (millions)	Arable land Percent of world total	Tractors	Acres per tractor	Note
U.S.A.	454.7	15.0	4,234,007	107	As of July 1, 1953
Canada	91.1	3.0	368,000	248	
Austria	4.4	0.1	16,000	275	
Belgium	2.5	0.1	7,000	357	
Denmark	6.7	0.2	38,000	176	As of Jan. 1, 1953 (3)
France	51.9	1.7	204,250	254	As of Jan. 1, 1953 (4)
Greece	8.2	0.3	5,000	1640	
Ireland	3.7	0.1	17,000	218	
Italy	38.0	1.3	66,000	576	
Netherlands	2.7	0.1	19,000	142	
Norway	2.0	0.1	10,000	200	
Portugal	14.3	0.5	5,000	2860	
Spain	47.4	1.6	10,000	4740	
Sweden	9.1	0.3	60,000	152	
Switzerland	1.2	—	20,000	60	
Turkey	36.6	1.2	16,000	2288	As of Jan. 1, 1953 (5)
United Kingdom	18.3	0.6	325,000	56	
Germany					
Western Zone	21.2	0.7	233,502	91	As of Jan. 1, 1953
Soviet Zone	12.4	0.4	12,000	1033	
Bulgaria	10.6	0.4	5,000	2120	
Czechoslovakia	13.6	0.5	29,000	469	
Finland	6.2	0.2	12,000	517	
Hungary	14.3	0.5	18,000	794	
Poland	41.5	1.4	22,000	1886	
Romania	23.0	0.8	15,000	1533	
Yugoslavia	19.5	0.6	7,000	2786	

TABLE 2 SPECIFICATIONS OF OFFICIALLY TESTED ENGLISH WHEEL TRACTORS
NOVEMBER, 1953

Manufacturer	Turner	David Brown	David Brown	David Brown	David Brown	New Fordson	New Fordson	New Fordson	Nuffield	Nuffield	Nuffield	Field Marshall	Ferguson	Ferguson	Ferguson
Model	—	Cropmaster 6	Cropmaster 6S	Super Cropmaster	Cropmaster Diesel	Major Diesel	Major Petrol	Major Vapor oil	DM-3	M-4	PM-4	3-A	TE-F20	TE-A20	TE-D20
Rated brake horsepower	—	30	—	35	—	40.5	39.5	38.5	39.0	—	43.0	40.0	28.0	—	—
Belt performance															
Maximum horsepower	32.2	25	28.3	32.2	29.3	37.7	35.6	32.4	36.7	—	40.8	40.4	27.0	28.4	26.1
Spec. fuel consumption — (lb per bhp-hr)	0.586	0.903	0.573	0.726	0.459	0.454	0.612	0.666	0.511	—	0.615	0.435	0.54	0.661	0.637
Engine															
Type	Four stroke	Four stroke	Four stroke	Four stroke	Four stroke	Four stroke	Four stroke	Four stroke	Four stroke	Four stroke	Four stroke	Two stroke	Four stroke	Four stroke	Four stroke
Fuel	Diesel	Vaporizing oil	Gas	Vaporizing oil	Diesel	Diesel	Gas	Vapor oil	Diesel	Vaporizing oil	Gas	Diesel	Diesel	Gas	Vaporizing oil
No. of cylinders	4	4	4	4	4	4	4	4	4	4	4	1	4	4	4
Bore and stroke, in	3¼ x 4½	3½ x 4	3½ x 4	3½ x 4	3½ x 4	3.937 x 4.524	3.740 x 4.524	3.937 x 4.524	3½ x 5	3.937 x 4.724	3.937 x 4.724	6½ x 9	3¾ x 4	3 11/16 x 3⅛	3 11/16 x 3⅛
Stroke-bore ratio	1.200	1.142	1.142	1.102	1.142	1.150	1.210	1.150	1.430	1.200	1.200	1.385	1.255	1.082	1.082
Rpm (governed)	1500	2000	1600	2000	1600	1600	1600	1600	2000	2000	2000	750	2000	2000	2000
Piston speed, fpm	1125	1332	1068	1332	1068	1208	1208	1208	1667	1575	1575	1125	1334	1210	1210
Compression ratio	17.5:1	4.7:1	5.5:1	4.7:1	15.0:1	16:1	5.5:1	4.35:1	16.5:1	4.5:1	6:1	16:1	17:1	6:1	5.1:1
Combustion chamber	Swirl chamber	Cylinder	Cylinder	Open	Open	Open	Open	Overhead valve	Swirl chamber	L-head	L-head	Precombustion chamber, valveless	Swirl chamber	Overhead valve	Overhead valve
Bmep, (lb max)	95.00	77.00	90.96*	84.1	94.2*	91.00	98.1	86.5	80.0	65.6	74.0	70.9	86.6	88.0*	81.0*
Starter	12-v	12-v	12-v	6-v	12-v	12-v	12-v	12-v	12-v	12-v	12-v	Hand or power cartridge	12-v	6-v	12-v
Clutch type	Foot pedal	Foot pedal	Foot pedal	Foot pedal	Foot pedal	Foot pedal	Foot pedal	Foot pedal	Foot pedal	Foot pedal	Foot pedal	Foot pedal	Foot pedal	Foot pedal	Foot pedal
Engine speed — DB	1200	2000	1600	2000	1600	1600	1600	1600	1400	1400	1400	750	1500	1500	1500
Travel speeds, mph															
Forward															
1	2.20	1.98	1.58	2.09	1.58	2.07	2.07	2.07	2.3	2.3	2.3	2.6	3.38	3.38	3.38
2	3.24	3.66	2.94	3.88	2.94	2.92	2.92	2.92	3.6	3.6	3.6	3.52	4.63	4.63	4.63
3	4.80	4.86	3.89	5.16	3.69	3.73	3.73	3.73	5.0	5.0	5.0	4.30	6.38	6.38	6.38
4	16.70	7.29	5.83	7.69	5.83	5.25	5.25	5.25	7.4	7.4	7.4	5.50	13.30	13.30	13.30
5	—	9.04	7.22	9.37	7.22	7.32	7.32	7.32	17.3	17.3	17.3	7.45	—	—	—
6	—	17.88	14.33	18.95	14.33	13.16	13.16	13.16	—	—	—	9.10	—	—	—
Reverse															
1	2.48	3.18	2.55	3.38	2.55	2.80	2.80	2.80	4.0	4.0	4.0	2.0	3.88	3.88	3.88
2	—	7.84	6.28	8.31	6.28	5.03	5.03	5.03	—	—	—	4.3	—	—	—
Differential lock	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Belt pulley															
Location	Rear	Rear	Rear	Rear	Rear	Right side	Right side	Right side	Left side	Left side	Left side	Left side	Rear	Rear	Rear
Diameter, in	11¼	8½	8½	8½	8½	8½	8½	8½	10¼	10¼	10¼	17	9	9	9
Width, in	7	5¼	5¼	5¼	5¼	—	—	—	6½	6½	6½	6½	6½	6½	6½
Rpm	1080	1400 & 2285	1120 & 1820	1400 & 2275	1220 & 1820	890 & 1600	890 & 1600	890 & 1600	1645	1645	1645	750	1358	1358	1358
Belt speed, fpm	3000	3100 & 5046	2490 & 4040	3100 & 5046	2490 & 4040	1980 & 3560	1980 & 3560	1980 & 3560	4510	4510	4510	3340	3190	3190	3190
Power take-off															
Diameter, in	1⅜	1⅜	1⅜	1¾	1¾	1⅜	1⅜	1⅜	1⅜	1⅜	1⅜	1⅜	1⅜	1⅜	1⅜
Rpm at DB test engine speed									527 at 1400	527 at 1400	527 at 1400				
1	540	680	595	682	595	722	722	722	engine rpm	engine rpm	engine rpm	535	727	727	727
2	—	1105	882	1105	882	—	—	—	—	—	—	—	—	—	—
Drive	TD	TD	TD	TD	TD	TD	TD	TD	TD	TD	TD	TD	TD	TD	TD
Tire size, in															
Front	6.00-19	6.00-19	6.00-19	6.00-19	6.00-19	6.00-19	6.00-19	6.00-19	6.00-16	6.00-19	6.00-19	7.50-18	4.00-19	4.00-19	4.00-19
Rear	14.00-30	11.25-28	11.25-28	11.25-28	11.25-28	11.00-36	11.00-36	11.00-36	11.00-36	11.00-36	11.00-36	14.00-30	10.00-28	10.00-28	10.00-28
Wheel tread															
Front	52-72	49 3/16-62⅛	49 3/16-62⅛	49 3/16-62⅛	49 3/16-62⅛	49¼-73¼	49¼-73¼	49¼-73¼	—	48-76	48-76	56	48-80	48-80	48-80
Rear	48-72	52-67½	52-67½	52-67½	52-67½	52-72	52-72	52-72	53-88	53-88	53-88	60	48-76	48-76	48-76
Wheelbase, in	71¾	74⅛	74⅛	74⅛	76⅛	80	80	80	82½	78	78	70	70	70	70
Turning radius, min															
Without steering brakes	10′ 10″	10′ 6″	10′ 6″	10′ 6″	10′ 6″	13′	13′	13′	10′ 8″	10′ 10″	10′ 10″	12′ 3″	9′ 7½″	9′ 7½″	—
With steering brakes	—	—	—	—	—	10′ 6″	10′ 6″	10′ 6″	—	—	—	—	8′ 9″	8′ 9″	8′
Brakes															
Hand	Yes	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes	—	—	—
Foot	—	Yes	Yes	Yes	Yes	—	—	—	—	—	—	—	—	—	—
Steering	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Overall Dimensions															
Height, less stacks	6′	4′ 8″	4′ 8″	4′ 8″	4′ 8″	5′ 3″	5′ 3″	5′ 3″	5′	6′ 1½″	6′ 1½″	6′	4′ 4″	4′ 4″	4′ 4″
Length	10′ 11″	9′ 8″	9′ 8″	9′ 8″	9′ 10⅛″	10′ 10½″	10′ 10½″	10′ 10½″	10′ 6″	10′ 3″	10′ 3″	10′ 2″	9′ 3″	9′ 7″	9′ 7″
Ground clearance, min															
Under middle, in	15″	16″	16″	16″	16″	12¼″	12¼″	12¼″	18½″	18½″	18½″	15″	13″	13″	13″
Under axle hsgs., in	—	—	—	—	—	23″	23″	23″	23″	23″	23″	—	—	—	—
Operating weight (less driver) lb															
Front	—	1225	1225	—	—	—	—	—	1470	1600	1600	2460	1092	1000	1000
Rear	—	1725	1725	—	—	—	—	—	2930	2850	2850	4060	1708	1550	1550
Total	4987	2950	2950	3400	—	4420	4360	4380	4400	4450	4450	6520	2800	2550	2550
Percent total weight on front wheels	—	41.5	41.5	—	—	—	—	—	33.4	36.0	36.0	37.7	39.0	39.2	39.2

*Belt mep

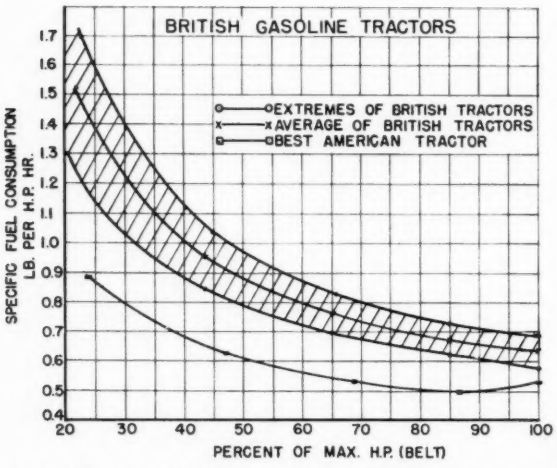
BRITISH GASOLINE TRACTORS
EXTREMES OF BRITISH TRACTORS
AVERAGE OF BRITISH TRACTORS
BEST AMERICAN TRACTOR
SPECIFIC FUEL CONSUMPTION LB. PER H.P. HR.
PERCENT OF MAX. H.P. (BELT)

Fig. 1 Official variable-load governed-speed gasoline performance of British wheel tractors

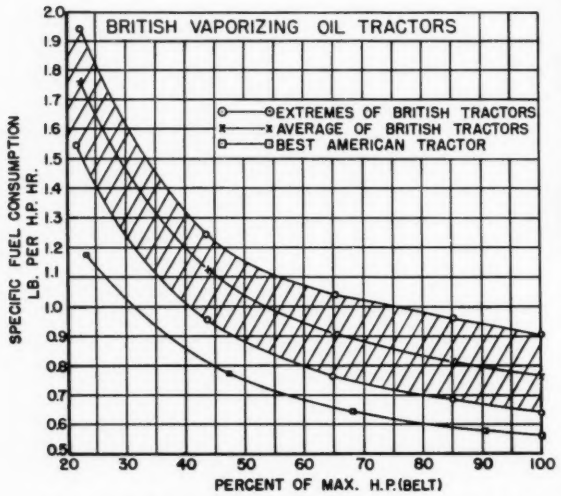
BRITISH VAPORIZING OIL TRACTORS
EXTREMES OF BRITISH TRACTORS
AVERAGE OF BRITISH TRACTORS
BEST AMERICAN TRACTOR
SPECIFIC FUEL CONSUMPTION LB. PER H.P. HR.
PERCENT OF MAX. H.P.(BELT)

Fig. 2 Official variable-load governed-speed vaporizing-oil (distillate) performance of British wheel tractors

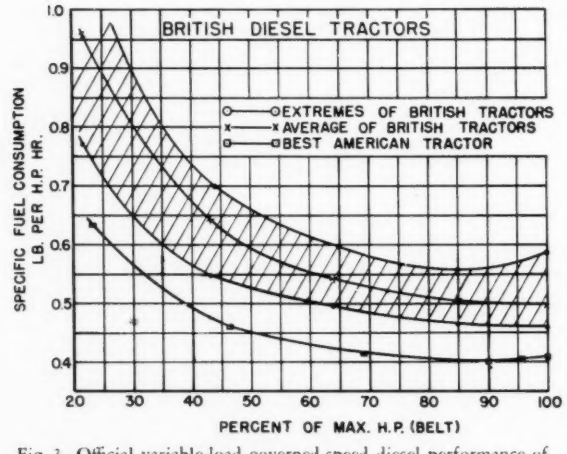
BRITISH DIESEL TRACTORS
EXTREMES OF BRITISH TRACTORS
AVERAGE OF BRITISH TRACTORS
BEST AMERICAN TRACTOR
SPECIFIC FUEL CONSUMPTION LB. PER H.P. HR.
PERCENT OF MAX. H.P. (BELT)

Fig. 3 Official variable-load governed-speed diesel performance of British wheel tractors

down the tooling and production costs of individual parts and reduces the inventory of repair parts. However, it increases the cost of the lower power models, as is evidenced by the difference in cost per pound between the Models 25 and 30C. Likewise discrepancies develop in performance characteristics, such as the 28-percent range in piston speed (from 1200 to 1533 fpm) and the range of travel speeds. Such illogical differences certainly reflect compromises made for production rather than performance reasons.

Another unusual feature of the design of the Model 25 is the 2-in offset of the center line of the tractor to the left. This is intended to increase the weight of the left rear wheel and reduce slipping when the right rear wheel operates in the furrow.

The transmissions are of the two-range type with one shift lever controlling the range and the other controlling

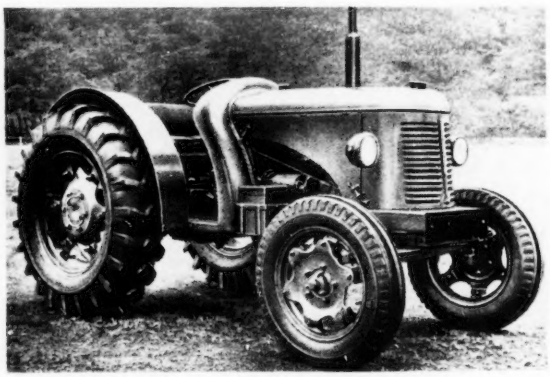

Fig. 4 David Brown Model 30C tractor

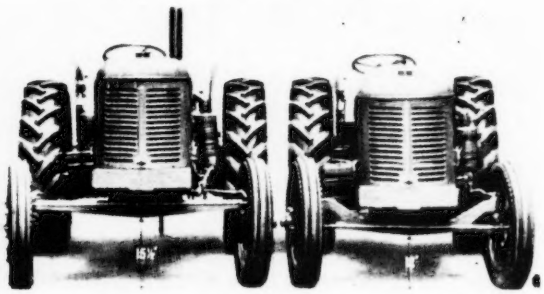

Fig. 5 David Brown Model 25K tractor—comparison of standard and wide-tread models

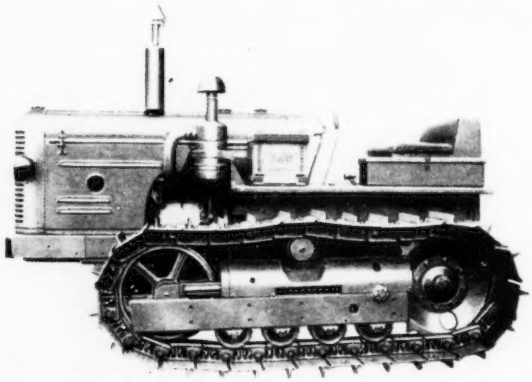

Fig. 6 David Brown "Trackmaster" diesel 50

TABLE 3. 1953 DAVID BROWN TRACTORS

(Data Source: *Farm Mechanization*, vol. V, no. 53, September, 1953—Manufacturers data.)

	Wheel tractors				Track-type tractors	
Model	25	30C	30D	50D	30TD	50TD
Prices	$1330.00	$1520.00	$1758.00	$2708.40	$3145.90	$4180.40
Fuel	gas. or dist.	gas. or dist.	diesel	diesel	dist. or diesel	diesel
Brake horsepower:						
Gasoline	37.5 at 2000 rpm	41.0 at 2300 rpm				
Distillate	31.7 at 2000 rpm	37.6 at 2300 rpm			37.6 at 2300 rpm	
Diesel			34.0 at 1800 rpm	50.0 at 1800 rpm	34.0 at 1800 rpm	50.0 at 1800 rpm
No. of cylinders	4	4	4	6	4	6
Bore and stroke, in	3½ x 4	3⅜ x 4	3⅜ x 4	3⅜ x 4	3⅜ x 4	3⅜ x 4
Piston speed, fpm						
Gasoline	1333	1533				
Distillate	1333	1533			1533	
Diesel			1200	1200	1200	1200
Displacement, cu in	154	165	165	247.5	165	247.5
No. of speeds—forward	6	6	6	6	6	6
—reverse	2	2	2	2	4	2
Travel speeds, mph						
(Rear tire size)	10-28	11.25-28	11-28	14-30		
First	1.82	2.28	1.73	1.40	1.19	1.19
Second	3.38	4.20	3.20	2.60	1.82	1.82
Third	4.49	5.60	4.25	3.45	2.47	2.47
Fourth	6.69	8.37	6.34	5.14	3.10	3.10
Fifth	8.32	10.40	7.83	6.39	3.78	3.78
Sixth	16.50	20.50	15.60	12.65	6.43	6.43
Reverse, low	2.93	3.66	2.78	2.25	1.42	1.42
Reverse, high	7.23	9.00	6.84	5.53	2.94	2.94
Over-all width, in	58.75	63.75	63.75	80.00	55 in with 40-in track	63 in with 48-in track
Weight, lb	3140	3890	3870	5785	7450	7900
Price per pound	$0.424	$0.391	$0.454	$0.468	$0.423	$0.528

the selection of the three basic speeds and reverse. Shifting is not straight line; i.e., when shifting from second to third speed, it is necessary to shift the basic speed from second to first and the range from low to high. The use of the two-range transmission also provides two belt pulley speeds and two power take-off speeds. Neither power take-off speed conforms to the United States and British standard of 536 rpm at rated engine speed.

Fig. 7 Elevation of Turner diesel tractor

David Brown tractors are provided with a three-point hitch, built to the Category I English Standard, which is dimensionally the same as that of the American-built Ford and Ferguson tractors. The top link includes an overload release which operates through a flexible cable to disengage the clutch at a predetermined draft overload. A hydraulic cylinder operating on a rear rockshaft controls the working position of the implements, but no automatic means of draft control is provided.

The Turner diesel tractor is manufactured in only one model. It is one of two English tractors having a standard power-shaft speed of 540 rpm at rated engine speed. This tractor is shown in elevation in Fig. 7 and in section in Fig. 8. It is provided with a four-speed transmission, drop-

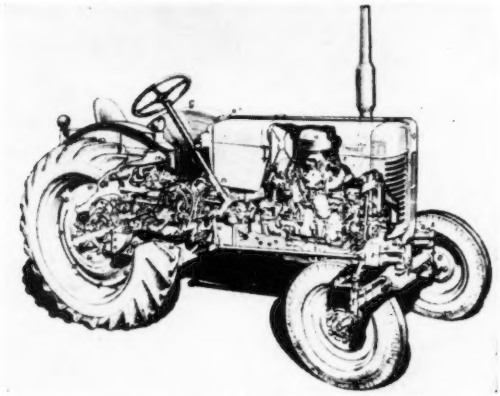

Fig. 8 Section of Turner diesel tractor

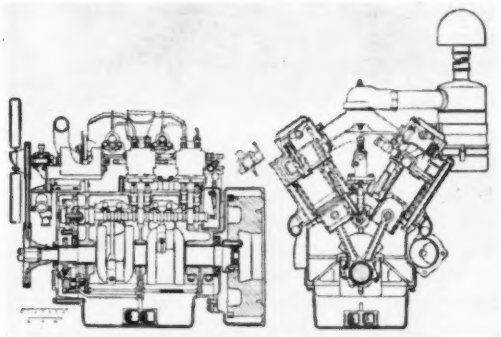

Fig. 9 Section of Turner diesel tractor engine

axle final drive, and a three-point hitch with an adjustable top link and low-pressure hydraulic lift without automatic draft control. The tractor features a four-cylinder, 68-deg, V engine, 3¾-in bore by 4½-in stroke, operating at 1500 rpm. The general construction of this engine is shown in Fig. 9. The cylinders are individually cast with the heads in pairs. Combustion chamber volume of each cylinder is adjusted during assembly with shims between cylinders and crankcase. Although this tractor developed the highest brake mean effective pressure of any English diesel tractor reported (95 psi), its specific fuel consumption was the highest (0.586 lb per hp-hr).

The English Ferguson tractor as shown in Fig. 10 is built in a single model with a number of variations. Except for the engine, it is in every way similar to its American counterpart. The belt horsepower of the American-built tractors is slightly greater.

To adequately meet varying requirements, Coventry-built Ferguson tractors are supplied with four types of engines, viz., gasoline, kerosene, distillate, and diesel. As of July, 1953, diesel engines constituted 40 percent of total engine production. The kerosene engine enjoys wide popularity in countries of the Middle East where fuel of very low octane rating is cheap and plentiful. In countries where gasoline is heavily taxed, the distillate engine has long provided an economical and acceptable answer. The popularity of diesel engines is world-wide, as evidenced by the high percentage of diesel to total production as just stated.

To meet the special demands of world markets, four different types of tractors are built. They are the regular-width tractor having a minimum over-all width of 64 in, the narrow-width tractor with 54 in minimum width, the extra-narrow vineyard tractor with a minimum width of 46-in, and an industrial version of the regular-width model for general haulage and industrial uses. All four types are supplied with gasoline, kerosene, or distillate engines. The diesel engine is supplied only for the regular-tread and industrial tractors. The treads of all models are adjustable in 4-in increments, the particular range of settings varying with tractor type as shown in Table 4. All belt-horsepower values are those delivered at 2000 rpm. Drawbar values were obtained at 1750 rpm for distillate and diesel engines, 1500 rpm for gasoline engines, and 2000 rpm for kerosene engines.

All engine transmission and hydraulic details are basically identical throughout the complete range of tractors, except the vineyard where the speeds in all gears are slightly lower due to smaller tire diameters.

As a means of overcoming the French import restrictions, Ferguson tractors are now assembled in France from components dispatched from Coventry. For this purpose, a new company, Societé Standard Hotchkiss, has been formed with a factory at Saint Denis sur Sein. Over 800 tractors have so far been assembled.

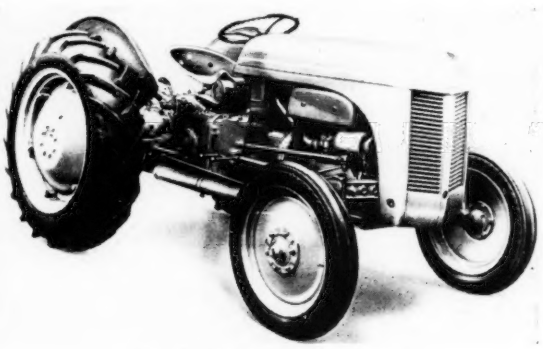

Fig. 10 English Ferguson tractor

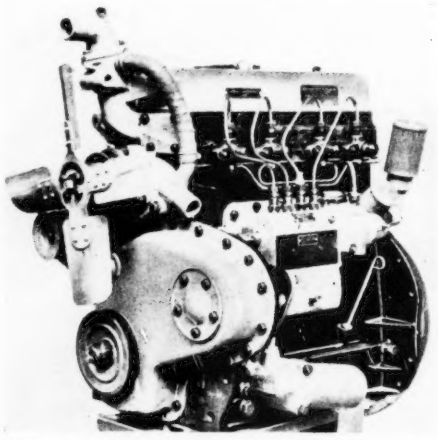

Fig. 11 Diesel engine used in English Ferguson tractor

The diesel engine used in Ferguson tractors is of especial interest. This engine is shown in Fig. 11. The engine with the cylinder head removed is shown in Fig. 12. The engine uses the Fowler-Sanders arrangement of air cell and combustion chamber, together with a pintle-type injector. This

TABLE 4. FERGUSON TRACTORS MANUFACTURED IN 1953 IN UNITED KINGDOM

Model	Belt hp	Drawbar hp	Fuel	Displacement, cu in	Weight, lb	Ground clearance, in: Under center	Ground clearance, in: Under axle	Tread adjustment (4-in steps)
Regular-width tractors								
TEA20	28.4	22.8	Gasoline	127.1	2480	13	21	Rear—48 in-76 in
TED20	26.0	21.4	Distillate	127.1	2480	13	21	
TEH20	22.9	20.7	Kerosene	127.1	2480	13	21	Front—48 in-80 in
TEF20	27.0	22.2	Diesel	127.3	2730	13	21	
Narrow-width tractors								
TEC20	28.4	22.8	Gasoline	127.1	2430	13	21	Rear—42 in-66 in
TEE20	26.0	21.4	Distillate	127.1	2430	13	21	
TEJ20	22.9	20.7	Kerosene	127.1	2430	13	21	Front—44 in-60 in
Extra-narrow vineyard tractors								
TEK20	28.4	22.8	Gasoline	127.1	2400	11	19	Rear—32 in-56 in
TEL20	26.0	21.4	Distillate	127.1	2400	11	19	
TEM20	22.9	20.7	Kerosene	127.1	2400	11	19	*Front—37 in-50 in
Industrial-width tractors								
TEP20	28.4	22.8	Gasoline	127.1	2990	13	Under	Rear—52 in-72 in
TER20	26.0	21.4	Distillate	127.1	2990	13	front	
TES20	22.9	20.7	Kerosene	127.1	2990	13	bumper,	†Front—48 in-80 in
TET20	27.0	22.2	Diesel	127.3	3305	13	14½ in	

*By reversing wheels, front wheel tread may extend to 58 inches maximum.
†Necessitates removal of side cover for settings under 52 in.

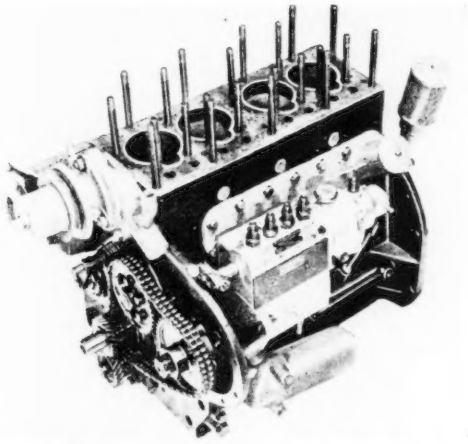

Fig. 12 English Ferguson diesel engine head removed to show air cells

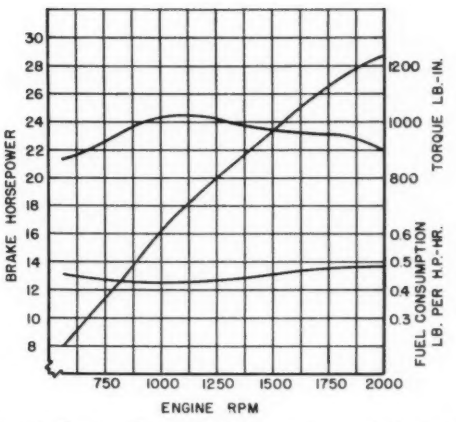

Fig. 13 English Ferguson diesel engine variable-speed performance (3)

engine has a bore and stroke of $3\frac{3}{16}$ x 4 in and at 2000 rpm the tractor delivers approximately 25 hp at the belt. The performance curves of the engine are shown on Fig. 13. It will be seen that the maximum brake mean effective pressure and torque are 100 lb per sq in and 1010 lb-in, respectively, at 1050 rpm, at which the brake specific fuel consumption is 0.426 lb per bhp-hr. Maximum power output is 28.8 hp at 2150 rpm. The compression ratio is 17 to 1.

The layout of the engine departs from conventional lines to provide adequate strength for a three-bearing crankshaft which is carried in a barrel-type crankcase. The camshaft is carried in three bearings formed by three bosses in the crankcase. Four bearings in pedestals on the head support the rocker arms and decompression gear. All of the injection equipment is mounted on the left side of the engine with manifolds, generator, and starting motor on the right side. The integral cylinder block and crankcase is cast of gray iron. The air cell is formed in the side of each cylinder bore at the top. The lower face of the crankcase is 5 in below the center line of the crankshaft. The oil pan is of cast aluminum.

The centrifugally cast dry-type liners are a slip fit in the cylinder bores. The wall thickness of the liners is $\frac{7}{64}$ in and that of the casting in which they are housed $\frac{7}{32}$ in at the wet surface, increasing to about $\frac{13}{32}$ in between the bores of the adjoining cylinders. Each liner is located at its top end by a flange seating on the shoulder in the bore of the block. A thin copper gasket fits under the flange. A unique arrangement at the top of the liner controls the build-up of carbon on the piston land above the top compression ring. It consists of two chrome-bearing gray iron cuff rings, the lower of which has an internal diameter slightly smaller than that of the cylinder bore. A cutout machined in the base of the liner coincides with a similar gap cast in the skirt in the crankcase to facilitate piston pin removal.

The general layout of the engine provides for assembly of the crankshaft and flywheel unit with the center and rear main bearings from the opening at the rear of the crankcase. For this purpose, the crankshaft bearings are mounted in large-diameter split carriers. The bores at the rear and center of the crankcase are $6\frac{3}{4}$ in in diameter to clear the crank webs. The forward carrier is 5 in in diameter as the clearance over the webs is not required. The bearing carriers are of cast magnesium alloy, split horizontally and held together by two socket bolts locked with spring washers. This serves not only to conduct heat away from the bearings but also to form rigid supports for the crankshaft, as due to the high coefficient of expansion the magnesium carriers expand tightly into their supporting bores in the gray iron crankcase.

The Nuffield tractors are the product of one of England's largest automobile manufacturers, Morris Motors, Ltd. This tractor is regularly built in a four-wheel, general-purpose type having a wheelbase of 78 in and with wheel treads adjustable front and rear. A general view of the tractor in operation is shown in Fig. 14 and in section in Fig. 15. A tricycle front-wheel arrangement is also available with a wheelbase of 82½ in as shown in Fig. 16. It will be seen that the draglink of this model is so located as to interfere with many front-mounted implements as we know them in this country. Rear-wheel tread may be changed in three ways for a total range of 52 to 88 in. By adjusting

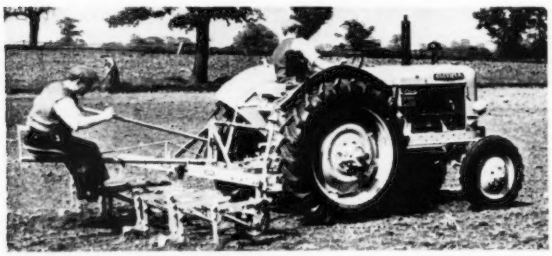

Fig. 14 Nuffield tractor with rear-mounted cultivator

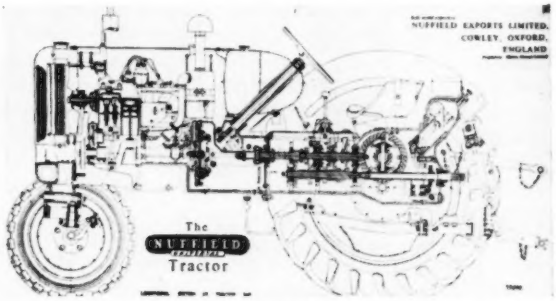

Fig. 15 Section of Nuffield tractor

the length of the front axle and reversing front wheels, the front-wheel tread may be adjusted from 48 in to 76 in.

Available dimensional and performance data of the tractors with three types of engines are shown in Table 2.

All tractors are optionally equipped with three-point implement attaching links and a hydraulic lift. At 1200 psi working pressure, the hydraulic system will lift 2330 lb applied at the end of the lifting arms in the lowest position and 2770 lb at the fully raised position. This is sufficient to disturb the stability of the tractor to a degree requiring front end weights, which may be bolted to the front of the cast iron frame.

Attention is called here to the rear-mounted integral cultivator shown with the Nuffield tractor in Fig. 14. Because of the inherently poor trailing characteristics of rear-mounted cultivators on three-point links, it is customary in both England and the European continent to have a man ride the cultivator to steer whenever precision work is desired. The order of precision so obtained is comparable with that of American front-mounted vegetable cultivators, so extensively used with tricycle tractors in the irrigated areas of the West.

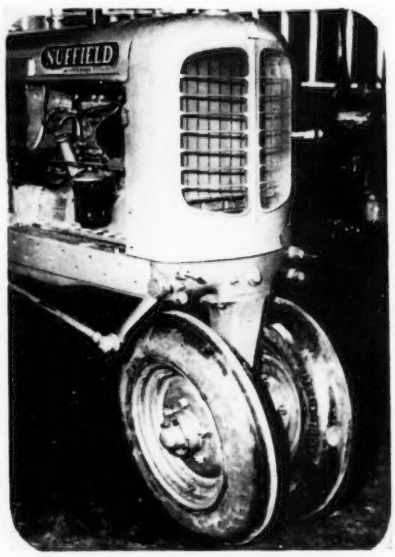

Fig. 16 Front view of Nuffield tricycle tractor

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(To be continued in the April issue)

Unified Electric Fence Code Needed

(Continued from page 154)

makes his purchase in the belief that the controller has been thoroughly tested. It will be recognized that this has reference to the system inherited with one of the codes, where the producer makes his own decision on compliance.

In an industry composed of small producers, and no central coordinating organization to help maintain standards, this type of testing cannot be relied upon. It is easy to misuse, either unconsciously or intentionally. It is recognized that the testing cannot be uniform or done by men specialized in testing work, also that different methods of testing will give different results. This system can also be used as a false protective umbrella for a producer to crawl under by writing his own admittance ticket. The label misleads farmers and tends to boycott the value of certifications by recognized testing agencies. It is impossible to see how there can be a code that educational agencies will support and use effectively, unless there is also a reliable agency set up for the public testing and compliance job required.

Another disturbing factor in the electric fence controller situation is the large proportion of unapproved controllers being sold annually. This is discouraging to manufacturers who attempt to market only approved units and to maintain standards. They are continually confronted with the temptation of adding unapproved units to their line to satisfy distributors and dealers who are anxious to meet competition from competitors with cheaper products. Apparently many farmers still do not appreciate the protection and durability provided in approved controllers. There must be found some way of stopping the present trend away from approved controllers.

Ways must be devised to make controllers as effective and economical as possible within acceptable code limitations. Education must be accelerated and made more effective not only with farmers, but also with dealers, jobbers and other distributors. Farm magazines, radio stations and other mass educational media must lend their support, perhaps to the extent of refusing advertising or commercials from producers of unapproved controllers. Improved educational and selling techniques to show fire and shock hazards or undependability of unapproved products would help the cause. More definite identification of acceptable units by educational agencies should also be considered.

To hasten desirable results, additional state legislation prohibiting the sale of controllers, which do not meet the requirements of acceptable codes, should be encouraged. At present the few states with such legislation do not reduce national sales volume sufficiently to adequately discourage production of unapproved units. So far as is known, there has been no electric fence fatality in Wisconsin since their state legislation was enacted 15 years ago. Additional legislation in even four or five other states with large user volume would help limit national sales of unapproved units sufficiently to discourage their production. The development of additional state codes and testing agencies should not be encouraged or necessary. All that is needed is more unification and agreement on what is already known about electric fencing.

An honest effort needs to be made to agree on what is best for the public and the industry — that is, a workable system that will lead to progress and improvement.

A Slide Rule for Soil Moisture Determinations

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Member ASAE

SUMMARY

THE authors have devised a special-purpose slide rule which in one operation successfully corrects the observed electrical resistance of Bouyoucos-type, plaster of Paris, soil-moisture blocks for soil-temperature variations, and converts the corrected resistance readings to percentages of available soil moisture in soils with average salt contents. Formulas for the construction of this slide rule as well as the more generally used correctional nomograms are presented, along with pertinent design data and instructions.

INTRODUCTION

A point of difficulty in the utilization of the electrical-resistance method of soil-moisture determination is the precise correction of observed resistances of the moisture blocks to compensate for soil temperatures. The electrical-resistance method was recognized as early as 1947 as one of the most practical instruments available for measuring moisture changes at tensions above one atmosphere in soils not containing large amounts of salts (1)*. However, because of the fact that variations in electrical resistance of the moisture block are occasioned by both variations in soil moisture and soil temperature, observed resistances of the blocks must be corrected for temperature prior to conversion to soil-moisture percentages. Such corrections are generally accomplished through the application of nomographs of varying degrees of simplicity, depending upon the accuracy of conversion to be achieved.

At the Michigan Hydrologic Research Station† daily resistance measurements have been made to determine soil moisture at a number of locations for several years, using the plaster of Paris moisture block developed by Bouyoucos and Mick (2). Nomographs were constructed to precisely correct these resistances to compensate for variation in soil temperature. However, the application of these nomographs to the raw field data has been a cumbersome and time-consuming task. Accordingly, studies were instituted at the station during the latter portion of 1952 with the objective of developing a similar but equally accurate method for correcting the resistances. These studies have resulted in the development of a special-purpose slide rule which quickly and accurately compensates moisture-block resistances for observed soil temperature, and converts the corrected resistance reading to percent available soil moisture, all in one rapid operation‡.

DEVELOPMENT

The nomograms previously used in correcting observed resistances, ranging from 0 to 260,000 ohms for temperatures between 25 to 90 F, made use of the relation

$$R_c = R_o^x \quad (3)$$

where R_c equals corrected resistance, R_o equals observed resistance, x equals $[1+0.002(t_o-t_c)]$, t_o equals observed temperature, and t_c equals corrected temperature. Substitution of 60 F for t_c in this equation corrects observed resistances to a base temperature of 60 F, which is used throughout this paper.

Thus, if an observed temperature is 60 F, the coefficient becomes unity, and no correction is made. On the other hand, if the observed temperature is greater than 60 F, the coefficient is greater than unity, and R_c is greater than R_o; and if the observed temperature is less than 60 F, the coefficient is less than unity, and R_c is less than R_o (4).

The formula in this form did not readily lend itself to slide rule application. Modification to permit the algebraic change of the exponent of R_o to $(T+440)/500$ permitted the application of logarithms to fractional exponential values. In its final form, this formula became

$$R_c = R_o^x$$

where R_c equals corrected resistance, R_o equals observed resistance, and x equals the expression $(T+440)/500$, where T equals any observed temperature. Using this formula, a slide rule was constructed which corrects observed resistances in the range of 500 to 260,000 ohms for temperatures ranging from 0 to 110 F, with a maximum error of approximately ± 0.3 percent.

The above formula was applied to variables of R in

This paper was prepared expressly for AGRICULTURAL ENGINEERING. Authorized for publication by the Director as Journal Article No. 1573 of the Michigan Agricultural Experiment Station, East Lansing, Mich.

The authors — ELMER F. ROWLAND, T. D. FAGAN, and GEORGE A. CRABB, JR.—are respectively, engineering aide, conservation aide, and hydraulic engineer, division of soils research, (BPISAE), U.S. Department of Agriculture, in cooperation with the Michigan Agricultural Experiment Station.

*Numbers in parentheses refer to the appended references.

†A cooperative study of the Michigan Agricultural Experiment Station and the Bureau of Plant Industry, Soils & Agricultural Engineering, U.S. Department of Agriculture.

‡The developmental studies were conducted under the guidance and general supervision of W. D. Baten, MAES statistician; G. J. Bouyoucos, MAES research professor of soil science, and B. M. Stewart, MSC associate professor of mathematics. H. F. Martin, sales representative, Whitehead and Hoag Co., slide-rule manufacturers, furnished blank slide rules for use in the study. The authors are happy to acknowledge these kindnesses and to express their appreciation therefor.

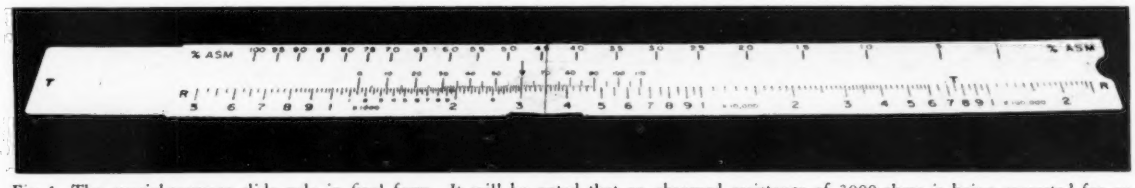

Fig. 1 The special-purpose slide rule in final form. It will be noted that an observed resistance of 3000 ohms is being corrected for an observed temperature of 70 F, giving a corrected resistance of 3500 ohms, which is indicative of approximately 44 percent available soil moisture

increments of 20, 25, 50, 100, 200, 500, 1000, 2000, 5000 and 10000 ohms, as desirable, to establish lineal markings of the slide rule. It was necessary to establish maximum and minimum lineal limits of resistance to fit the 17.5-in length of blank slide rule used in this study. To accomplish this, the equation $R_c = R_o^x$ was written loglog R_c = log x + loglog R_o and the following procedure was used:

$$\text{Rule length} = m \log\log 260{,}000 - m \log\log 500$$
$$17.5 = m \log 5.41 - m \log 2.69$$
$$m\ (0.73360) - m\ (0.43119)$$
$$m\ (0.30241)$$
$$m = 17.5/0.30241$$
$$= 57.87$$

In laying out the rule, the longarithm of the resistance was multiplied by the modulus *(m)*, giving the measured distance to the right of the zero point of the slide rule. A modified four-cycle logarithmic pattern was laid out to achieve the desired range, with appropriate subdivisions (D scale). A review of the existing resistance-temperature records of the Station showed that the general range of resistance and temperature has been between 700 and 4,000 ohms and 40 and 80 F during the growing season. With this layout, the general range fell slightly to the left of the center of the *R* scale on the rule, and thus permitted a greater number of relatively small-valued divisions in this range. Layout patterns can be developed for other specific ranges, and applied to similar slide rules of various lengths by revaluation of the modulus.

The temperature scale (C scale), being also a function of the logarithmic values with respect to *m*, is laid out similarly. However, rather than being designed from the zero point as in the case of the resistance scale, this scale was constructed from 67 F each way, in accordance with the formula, $m \log (T+440)/500$. Since the log of 1 equals 0.000, deviations to the right or left of the designated 60 deg become plus or minus, and thereby incorporate the function of correction.

APPLICATION

Moisture-block resistances, when corrected as above, are ready for conversion to percent of total soil moisture by means of calibration curves. For best results, it is advisable to calibrate each block in the soil in which it is to be installed, plotting the resistances against their equivalent percent of total soil moisture. However, it is sometimes advisable to convert the corrected resistance readings to percent of available soil moisture. This does not require individual calibration of the moisture block, for Bouyoucos has found that the electrical resistance of his moisture blocks, when buried in soils of average salt content, has a direct relationship to the available moisture content of those soils (5). The authors, working from these original data, tabulated the corrected resistances for specified percentages of available soil moisture. This tabulation, when graphically presented on the A scale of the slide rule, and in direct relation to the equivalent resistances of the D scale, permits the ready conversion of temperature-corrected resistances to percent of available soil moisture without further manipulation. Thus temperature-corrected resistances and percent available soil moisture may be read from the same setting of the slide rule.

USE OF THE SLIDE RULE

The slide rule in its final form is shown in Fig. 1. To use it for temperature corrections, place the index arrow (which corresponds to 60 F on the T scale) directly above the observed resistance. Then move the cursor until the hairline falls directly over the observed temperature. The corrected resistance can then be read on the R scale, beneath the hairline, and available soil moisture immediately above on the A scale.

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The Henry Phase Converter

TO THE EDITOR:

IN THE article, entitled "Performance of the Henry Phase Converter," published in the February issue of AGRICULTURAL ENGINEERING, the authors made no reference to the recent design of capacitor-start capacitor-run single-phase motors which have all of the advantages claimed for the converter with none of the disadvantages. Their comparisons were with the repulsion-induction design motor which is being superseded by the other type. At least three manufacturers are now making the capacitor-start capacitor-run motor. Two of these no longer make the repulsion-induction motor.

It may be that the authors did not have knowledge of these new design developments of single-phase motors. We are taking steps to bring them up to date in this particular case.

The main reason for calling this matter to your attention is to forestall any possible criticism of AGRICULTURAL ENGINEERING in the future from manufacturers or others where their products or interests are concerned. In the case of articles written expressly for AGRICULTURAL ENGINEERING, an author may not always know of the latest developments of equipment concerned and may present a picture that is not always complete or up to date and thus convey an erroneous impression. To guard against any possible criticism, it seems to me that articles written expressly for AGRICULTURAL ENGINEERING should be reviewed by qualified individuals before they are published. In the case of papers presented at ASAE meetings, there is generally time between presentation and publication so that criticisms or comments can be received, but not so with special articles such as the one mentioned here.

The foregoing comment is offered as a constructive criticism and to help guard against any possible criticisms of the Society or of its journal.

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Farm electrification
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New Developments in Fertilizer Machinery

C. E. Guelle
Member ASAE

WIDESPREAD increase in the use of fertilizer has increased the demand for application equipment. It has also resulted in an insistent demand for equipment that will give the buyer maximum returns from his investment in four ways:

1 Longer life for fertilizer-application equipment

2 Machinery that will further reduce the cost of handling fertilizer in the process of its application

3 More accurate metering of fertilizer over a wider range of quantities per acre, due to trends toward use of higher analysis fertilizers as well as toward heavier applications

4 Placement of fertilizers in relation to both seed and growing plants so as to produce maximum returns from the fertilizer investment.

Because of the effect of the chemicals in fertilizers on the life of application equipment, this paper will deviate slightly at this point from the assigned title to report on the program sponsored by the Subcommittee on Fertilizer Application of the Farm Equipment Institute.

During the past several years, it has become quite apparent to our subcommittee that the corrosive effect of different fertilizers on application machinery is a major problem. This corrosion both shortens the life of the distributing mechanism and lessens the accuracy with which fertilizer is distributed.

In full recognition of the problem it was decided that a cooperative program should be set up within the farm implement industry in an attempt to find materials and/or coatings which would more successfully resist corrosion and still be within an acceptable price range.

Since the inauguration of this program considerable work has been done in setting up test procedures and equipment which would reproduce field conditions. This is being done with standard fertilizer-distributing equipment under controlled temperature and humidity.

This paper was presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1953, as a contribution of the National Joint Committee on Fertilizer Application and the Power and Machinery Division, ASAE.

The author — C. E. GUELLE — is manager of seeding, potato and beet machinery sales, International Harvester Co.

NEW MATERIALS AND COATINGS

Many companies in the industry are conducting studies of new materials and coatings. Results are still far from conclusive but some progress has been made. Everyone fully realizes that it is an old problem—it was old when chemical fertilizers first came into use. Within the economic limits presently imposed on the industry by its customers, a complete answer within a short time cannot be promised.

Corrosion is of course the chief problem as far as primary materials of manufacture are concerned. Abrasion followed by corrosive attack on the basic material also enters the picture when the solution to our problem is sought in the form of coatings.

Considering first the basic materials commonly used in fertilizer-application machinery, grey iron presently seems to offer the best compromise between cost and corrosion resistance. However, this is due to sheer mass rather than to any inherent resistance to corrosion. In one series of tests grey iron parts in the distributing mechanism corroded to approximately the same extent as the hopper. However, due to the fact that the parts were approximately $\frac{3}{16}$-in thick, the percentage of metal lost through corrosion was negligible. These tests were conducted for a three-month period, during which the hoppers were operated 420 hr, being stationary the balance of the time. The hoppers of galvanized sheet steel showed a 10 percent loss of weight from corroded areas and an 8 percent loss of thickness. The corrosion products adhered tightly to the corroded surfaces and to a certain extent acted as a protective coating. However, vibration and impact in the field probably would remove most of such corrosive products and corrosion in actual use would be accelerated.

From the laboratory of another manufacturer comes this report: "We have found that the only solution is to put stainless steel in certain portions of the equipment—primarily the working parts and, as a rule, the bottom portions of the hoppers. We have quite a number of these in the field with stainless steel and are experiencing no corrosion problems whatever. Unfortunately it is a costly method but probably in the long run is less expensive than any other material presently being used. We also are experimenting with a cer-

The McCormick No. 1 pasture renovator *(left)* improves rundown pastures and grassland without previous seedbed preparation and with minimum disturbance of the existing cover crop, which permits longer grazing seasons, eliminates seedbed preparation in areas where heavy rainfall or winds make it hazardous to leave soil exposed to the erosive effects of the elements • The McCormick No. 6 fertilizer distributor *(right)* is equipped with an agitator attachment for breaking up lumpy fertilizer and providing additional agitation for damp or sticky materals, also adjustable scatter boards that serve as windshields and deflect the fertilizer for the desired scattering effect

The large-capacity hopper of the McCormick No. 6 fertilizer distributor *(left)* holds 2 cu ft of material per foot of hopper length. The machine will spread all of the many types of commercial fertilizer, salt, sand, calcium chloride, weed-killing poison dusts, or other free-running materials. It has a wide range of accurate spreading rates to meet all requirements down to approximately 8500 lb per acre of basic slag, depending upon condition of materials. The removable hopper bottom *(right)* is an important feature of this machine. By loosening the winged hex nuts, and swinging the retaining clamps out of the way, the hopper bottom can be slipped off for easier and more thorough cleaning and inspection of the feed mechanism.

tain type of fibre glass as part of some of the units, to see how this material will withstand wear. It is still too early to report conclusive results."

In the same vein another manufacturer reports that stainless steel has proved entirely satisfactory, resisting both corrosion and abrasion when used for distributor tubes. But again the problem is raised: will the extra life justify the extra cost in the eyes of the purchaser?

Other materials being tested or considered for test include molded rubber and various plastics which, in laboratory tests, have shown excellent corrosion resistance.

Coatings. Studies of coating has been mainly in relation to hoppers although at least one laboratory in the industry is conducting tests on fertilizer distributor rotors with cadmium plating over copper plating, and with chrome plating over copper plating. These tests have not been carried on long enough to justify conclusions.

The same laboratory is experimenting with hoppers made of sheet steel covered with a lead-tin alloy, commonly designated ternplate, and now widely used in the manufacture of tractor fuel tanks. Corrosion tests in the laboratory indicate that this coating offers improved protection within a cost range that is not prohibitive. Results from field tests are not yet available.

The findings of one manufacturer just about sum up the present situation in regard to coatings. This company reports: "During the past five years we have experimented with every conceivable type of coating and finish that is available and found none that will give any reasonable lasting effect. After six or eight months they would break down and the metal would be exposed to the acid in the fertilizers, which would attack metal and shortly start corrosive action."

Another laboratory makes this observation: "We would question any program of testing which did not take into account the abrasive action encountered in field use, plus scraping or gouging that occurs when the farmer cleans the equipment. We recognize that many types of organic finishes which develop good hardness and are so compounded as to resist all the commercial fertilizer products will perform satisfactorily if the farmer can be educated to care for them as he normally would the finish of his automobile."

The foregoing pretty well sums up the present situation in regard to materials and coating.

IMPROVEMENTS IN EQUIPMENT

Aside from one machine, new developments can be classified as refinements in present types of machines to provide

- Better metering
- Bigger capacity
- More accurate placement.

The new machine to be described in this paper is designated by various manufacturers as "pasture dream", "grassland drill", and "pasture renovator". As its name implies, it is used for fertilizing and reseeding pastures, but it also has advantages when used for fertilizer application alone.

Essentially these machines combine a chisel cultivator, grain drill with grass-seed attachment, and a fertilizer distributor with deep applicators. Different makes of these machines are now on the market or shortly will be. They may differ in detail though not in principle, so I will describe one with which I am most familiar. The coulter slices into the soil cutting grass and weed roots. It also helps to prevent the point of the applicator from striking obstructions. The pointed applicator opens the coulter slot and the boot holds the soil apart long enough to place the fertilizer in the bottom of the trench thus opened. Unhulled grain or grass seed is delivered to the ground behind the fertilizer boot through flexible ribbon tubes. The ends of the tubes can be set up or down and close to or away from the fertilizer boot to place the seed in desired relationship to the fertilizer. Clover and similar seed may be applied either in front of or behind the press wheel which completes each ground-working unit. The press wheel also serves as a gage wheel.

As this description will indicate, these machines may be used to fertilize and reseed wornout pastures in one operation. The resulting band seeding, judging from recent studies at Beltsville and other locations, may reduce the seed required for profitable grass yields by as much as 50 percent. The fertilizer may be placed several inches below the surface of the ground, resulting according to many studies in more

efficient utilization of the plant food and better grass stands than when broadcast.

Another advantage of these machines, in addition to fuel and labor saving, is that they leave the surface of the ground relatively undisturbed. Grass already growing is not destroyed as it is by other methods of pasture renovation. It quickly benefits from the application of the fertilizer. Livestock can continue grazing without interruption during and after the renovation process. When used on the contour, the slits made in the soil by the applicators increase water-absorbing rate and capacity.

These machines can be used in many ways namely, as combination machines as described above, as fertilizer distributors for shallow or deep-band application alone, as grain drills and fertilizer distributors, or as grass seeders, either band or broadcast type.

Major improvements in conventional broadcast fertilizer distributors are not spectacular. But they are keeping pace with requirements as set forth by the results of recent research on the most efficient use of fertilizers. Many improvements have been made to give more uniform distribution over a wider range of quantities per acre. One distributor, for example, has a range of from 10 to 8,500 lb per acre and will meter accurately all the various types of fertilizers now commonly available.

In the battle against corrosion, several manufacturers have made it much easier for the user to clean the distributor. Machines are now available with hopper bottoms either hinged or completely removable in a few minutes, giving ready access to the feed wheels and hopper bottoms for thorough cleaning. These hopper bottoms can be replaced, in the event of eventual failure from corrosion, at a lower cost than for replacing the entire hopper.

Bearings and gears are also being better protected from contact with the fertilizer, thus reducing the possibilities of corrosion.

To reduce the number of stops the farmer must make when applying fertilizer, distributor hoppers are being made larger. This observation applies both to broadcast distributors and to fertilizer units for planters, cultivators and other equipment.

This demand for larger hoppers stems from two conditions: First, it is likely that larger amounts of fertilizer will have to be handled in the future for side-dressing row crops. Second, the effort now involved in putting fertilizer in hoppers on cultivator attachments is regarded by most users as excessive. Certainly one almost needs to be a contortionist to empty a bag of fertilizer into the inside hoppers on a four-row cultivator.

Experiments are now under way to solve this problem. In general, experimental designs include a carrying frame, rear-mounted on the tractor, and supporting a single hopper having greater capacity than the sum of the individual hoppers now used on two and four-row cultivators. The top of this single hopper is at truck-bed height, making it easy to dump fertilizer sacks or scoop bulk fertilizer into the hopper.

From the hopper, distributing means are provided to direct the fertilizer to applicators spaced as desired on a tool bar.

Preliminary experience shows that this fertilizer application unit for row crops improves the visibility afforded the tractor driver. Also better weight distribution between front and rear improves steering characteristics of the tractor.

The problem of applying larger amounts of fertilizer also is affecting requirements for fertilizer application units on row-crop planters. It is generally known that quantities of starter fertilizers above a certain level are of little or no value. However, a deep application of the proper analysis at planting time can have decided benefits. This problem is being solved by mounting units with deep applicators forward on the tractor, while the starter fertilizer is applied by units on a rear-mounted or trailing planter.

New designs for a metering mechanism applied to fertilizer units on row-crop planters also have successfully passed through the experimental stage and are now available on some types of planters. This new unit employs a rotating flat-hopper bottom with a rim which impels the fertilizer through vertical, triangular-shaped metering openings. The application range is from about 100 to 3,000 lb per acre.

This type of mechanism has displayed certain advantages. It provides a more uniform flow, whether the fertilizer is free running, lumpy or wet. In several years use, no trouble has been experienced from breakage due to foreign materials. It has a wider metering range which can be varied in small increments. Thus it is equally suited to applying either high or low analysis fertilizers in the exact quantities desired. It is also easier to clean after use.

Developments in the extension of fertilizer use to new areas, in the demand for heavier applications in other areas, and in the design of fertilizer attachments for grain drills, are taking place along the following lines:

In general, fertilizer attachments in both experimental and production units are being placed behind the grain hopper instead of in front. Separate distributor tubes are provided instead of directing the fertilizer flow into the grain tubes. Adjustable brackets at the discharge end of the tubes allow adjustment to meet all common requirements for placement of the fertilizer in relation to the seed. The fertilizer tubes may be adjusted to place fertilizer

- Mixed with the seed
- Back of the furrow openers, allowing as much or as little soil as desired to cover the seed before the fertilizer is deposited
- In a band alongside the seed, by means of applicators.

This design eliminates the caking of fertilizer in the grain-drill feed mechanism, and also keeps it away from the bearings of disk-furrow openers. Wherever tried to date by agricultural experiment stations, it has been generally accepted as a marked improvement. Especially beneficial results from the standpoint of crop yields have been reported by growers of green canning peas.

Developments are proceeding along the lines that will make these new attachments applicable to grain drills now in use, as well as to new drills. The intention of the industry is to adopt this design just as rapidly as design and manufacturing problems can be solved so that the attachments can be placed in production.

The farm implement industry is keeping pace on many fronts with the findings that come from the research of soil specialists and agronomists. We have many problems still to solve, particularly that of combatting the corrosive action of the chemicals used in fertilizers. But progress is being made in making available fertilizer application machinery that is far more durable, far more accurate and offers far greater time-saving than that available only a short time ago.

The Georgia - USDA Peanut Harvester

Charles E. Rice and James H. Ford
MEMBER ASAE MEMBER ASAE

EFFECTIVE peanut harvesters using two methods of separation have been developed as a part of the peanut mechanization program carried on cooperatively by the Georgia Coastal Plain Experiment Station and the Division of Farm Machinery of the U.S. Department of Agriculture. These machines will handle green, semidry and dry peanuts and have relatively high capacities, approximately 2 tons per hour in dry peanuts. W. D. Kenney and J. L. Shepherd described the first unit developed on the project in an unpublished paper, entitled "Developing a Peanut Combine Harvester," presented at the ASAE Southeast Section meeting in Biloxi, Miss., February, 1948. They listed the following design and operation requirements:

This paper was prepared expressly for AGRICULTURAL ENGINEERING. Approved as Journal Paper No. 21 of the Coastal Plain Experiment Station.

The authors — CHARLES E. RICE and JAMES H. FORD — are, respectively, agricultural engineer, Georgia Coastal Plain Experiment Station, and agricultural engineer, farm machinery section, Agricultural Research Service, U.S. Department of Agriculture.

Acknowledgment: The authors express their appreciation to J. L. Shepherd, agricultural engineer, Georgia Coastal Plain Experiment Station, and I. F. Reed, senior agricultural engineer, U.S. Department of Agriculture, for their help, suggestions and guidance, and to W. D. Kenney and M. O. Berry, formerly with the station and the USDA for their contributions in the earlier part of this program.

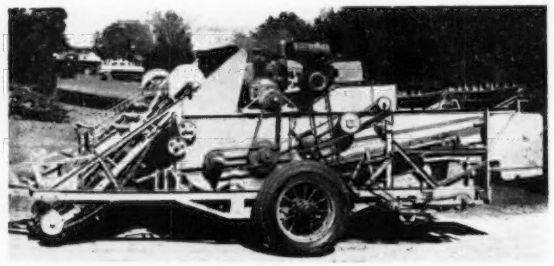

Fig. 1 The 1951 peanut harvester using raddle arrangement for separating peanuts from the hay

1 Cylinders and pickup unit of sufficient width to allow a uniform thin spread of material through the machine

2 Picking cylinders that are rugged, aggressive, self-cleaning, of equal or greater width than the pickup, handle green or dry vines, and not damage the peanuts

3 Positive separation of the picked nuts from vines under all conditions

4 Arrangement for feeding material to cylinders at uniform rate

5 Sufficient power furnished through a positive transmission system to provide a large overload factor.

The first experimental harvester developed in an attempt to meet these requirements consisted essentially of a pickup unit based on a design found to be effective on commercially available peanut shakers, two intermeshing spike-tooth cylinders operating over perforated steel grates through which adjustable retarding fingers protruded for picking, and a vibrating vine rack for separation. Selected spikes in each cylinder long enough to just clear the grate helped to keep the grates relatively clean. A beater or doffing cylinder cleaned the material from the last picking cylinder and distributed it on the separating rack. This harvesting arrangement did a satisfactory job, but the stresses due to the rapid movement of the heavy vine rack necessary to remove the peanuts from heavy green vines caused excessive breakage both on the experimental harvester and on the commercial machines built on a preproduction basis. The pickup and picking-cylinder arrangement worked so effectively that they were retained with slight modifications in the 1951, 1952 and 1952 modified harvesters.

THE 1951 HARVESTER

The separating principle used in the 1951 model harvester (Fig. 1), is shown schematically in Fig. 2. The vine rack was replaced with a separating cylinder of spring teeth operating over an expanded-metal concave and a steel raddle

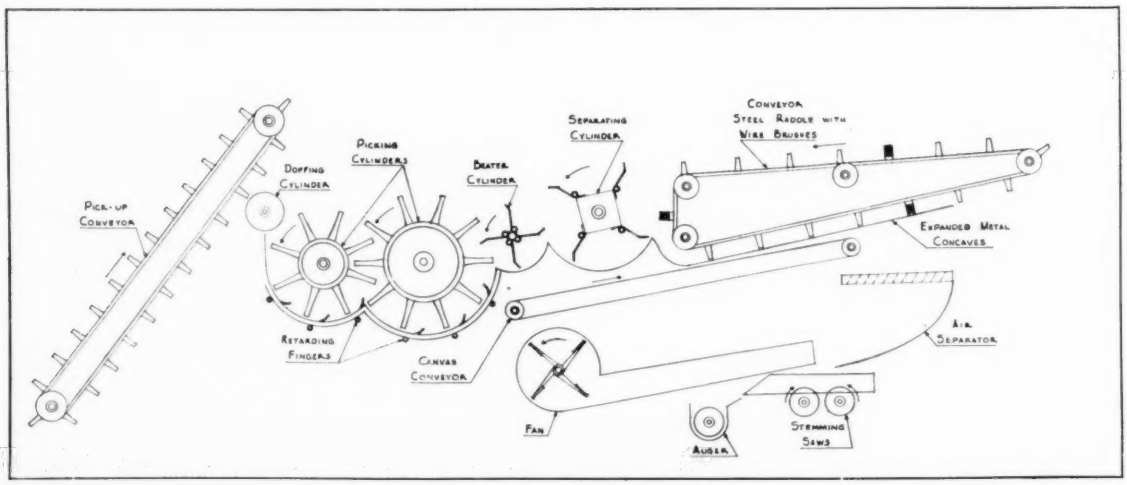

Fig. 2 Schematic drawing showing relative arrangement of units in the 1951 harvester

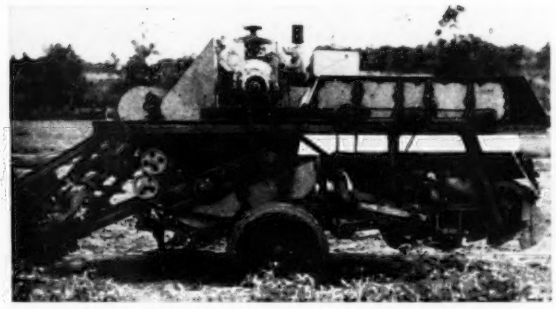

Fig. 3 The 1952 peanut harvester utilizing cylinders for separating peanuts from the hay

arrangement operating over an expanded-metal screen to reduce vibration and to provide a positive method of moving the peanut hay through the separating mechanism. The screen under the raddle bars has openings of the size used in carding-type pickers. Raddles 3 in long and spaced 7¼ in on centers on the raddle bars carry the hay over the screen. Three bars were replaced with steel brushes to aid in keeping the screen clean when operating under adverse conditions. Peanuts, leaves, dirt, pieces of stems, etc., pass through the screen to the canvas conveyor which carries them back and drops them through the air blast. The air blast removes the light material, and heavy dirt, stems, etc., are removed by the stemming saw assembly. Approximately 275 acres of Spanish, Runner and Virginia-type peanuts in conditions ranging from green to dry and containing varying amounts of weeds and the other foreign material have been picked with this machine.

The relatively high capacity of the 1951 harvester varied from about 1 acre per hour for green peanuts to 3 acres per hour for dry peanuts in six-row windrows. A field test made during average operating conditions in which all material that went into the machine was collected, gave this machine an operating efficiency of 96 percent. The peanuts harvested that were above saleable moisture content were artificially dried. Those harvested during 1951 and 1952 graded from zero to one percent damage. The damage went up to 4 percent during the 1953 season due to extremely wet weather during the three weeks that some of the peanuts were in the windrow. None of this damage can be attributed to the machines. This compares with an average high of 10 percent damage to stacked peanuts. This information was secured from the local peanut buyers. Adjustments to the cleaning mechanism enabled keeping the foreign material due to sticks, stems, etc., relatively low. The three seasons work with this harvester has proven that the picking and separating methods are based on sound principles. The harvester is effective under practically all field conditions, it is economical to operate, and has the high capacity requested by peanut growers.

THE 1952 HARVESTER

In a planning meeting November 28, 1951, arrangements were made to investigate the possibilities of using cylinders for separation in place of the chain and raddle unit used in the 1951 harvester. The objectives of this development were (1) to lower cost of construction, (2) to obtain a more compact harvester, and (3) to reduce upkeep and field troubles. The harvester shown in Fig. 3 was completed during the summer of 1952. The picking and separating arrangements are shown schematically in Fig. 4. The pickup and picking units were the same as those used in the 1951 harvester except that the front picking cylinder was lowered and the pickup shortened. The separating unit consisted of three spring-tooth cylinders 24 in in diameter operating over expanded-metal concaves. Cylinder units and concaves were easily removable for replacement, repair or cleaning. The canvas conveyor carried the peanuts, leaves, etc., forward and dropped them through the fan blast which discharged near the center of the machine. This machine effectively picked the peanuts and separated them from the hay with

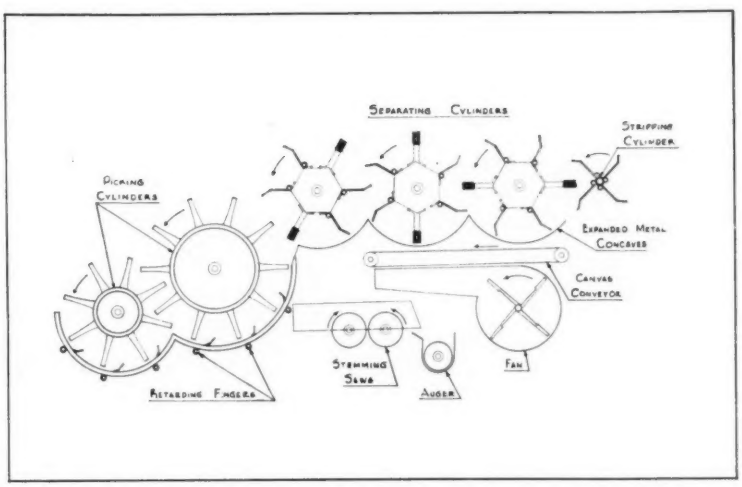

Fig. 4 Schematic sketch of the 1952 harvester showing arrangements of units. The limited area for discharging the air and light trash is shown

the first picking cylinder operating at 190 rpm, the second at 230 rpm and the separating cylinders operating at 50 rpm. It was necessary to operate all separating cylinders at the same speed as two rows of steel brushes were added to each

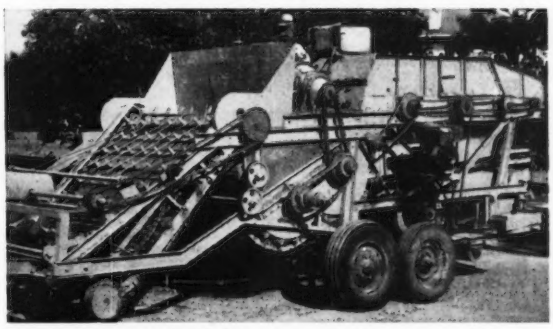

Fig. 5 The 1952 modified peanut harvester with power-take-off-driven pickup

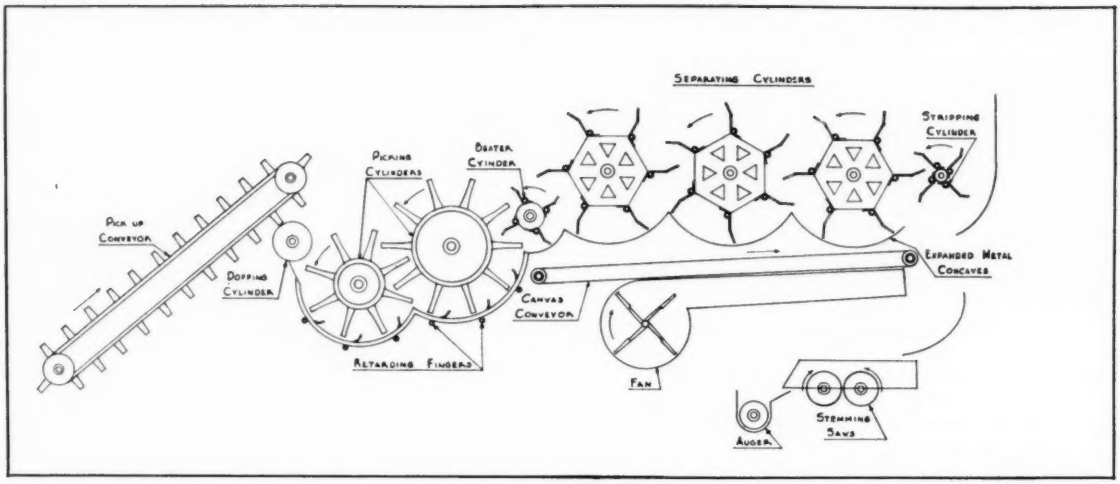

Fig. 6 Schematic sketch of the 1952 modified harvester which has resulted in a compact, effective machine

cylinder and they had to be timed to never come together. Though the machine operated smoothly and effectively under favorable conditions, it was noted that there was a tendency for the fan arrangement to be ineffective. There was not enough room to discharge the trash and air under the machine.

THE 1952 MODIFIED HARVESTER

The 1952 modified harvester shown in Figs. 5 and 6 was modified before the start of the 1953 harvest season by (1) arranging to drive the pickup from the tractor power take-off, (2) increasing the size of the separating cylinders and concaves to 30 in, (3) installing a stripping cylinder to clean the second picking cylinder, and (4) reversing the fan unit and moving the stemming saw assembly to the rear. The power-take-off drive for the pickup enabled the tractor driver to effectively control the rate of feed into the machine. The simple, smooth operating separation unit proved to be even more effective than the 1951 harvester, and was suitable for both green and dry peanuts. Tests showed that large quantities of wet soil and wet vines tended to clog the concaves and reduce separating efficiency. Previous tests during the fall of 1952 indicated that this difficulty can be alleviated by the addition of steel brushes to the separating cylinders. This was not done during 1953 as they were not needed too greatly. The effective no load cylinder speeds for this machine were 210 and 240 rpm for the picking cylinders and 280, 110, 100, 80, and 110 rpm for the separating cylinders from front to rear. These speeds dropped about 10 percent under load.

SUMMARY

Three years of test and development work on the 1951 model peanut harvester using a chain and raddle assembly over an expanded metal screen for separation and two years on the 1952 model harvester using cylinders over concaves of expanded metal have proven the economy, effectiveness, and smoothness of operation of these methods. Machines incorporating these designs have relatively large capacity, will operate under adverse as well as favorable conditions, will reduce labor requirements over non-combine methods of harvesting peanuts, and will pick and separate peanuts both green and dry. Both peanut growers and manufacturers of peanut-harvesting machinery have shown considerable interest in these developments. At least one manufacturer is developing and testing an experimental harvester using cylinders for both picking and separation.

Operational tests of both machines made during the 1953 harvest season indicate that additional studies are needed to improve the flotation and mobility and to decrease the over-all weight of the machines. Further research will be aimed toward refining the principles of operation with emphasis being placed on increasing the efficiency and improving the performance of both harvesters.

Making a Better World

SOME day, perhaps, the inhabitants of this planet will come to their senses and devote themselves in united human effort to creative good. In such a world, the energies of two and a half billion men and women might be directed at high technical adventure. They might pool their machinery, equipment, skills, labor, and capital to improve the backward areas of the earth. Together they could irrigate the world's deserts, including the one-third of our own country that is arid. They might control floods, droughts, and storms, and build an international weather station on Everest. They might explore the world under the sea, drill a second five miles into the earth, and see whether that rocket really can be launched from Earth to Moon.

It is not enough that engineers have given us the stunning scientific triumphs that have blessed this land in so many ways. It must be decided now whether or not they will help us to use that science for even better ends. Somehow the nature of man must be made to grow spiritually and intellectually. Somehow our hearts and minds, our morality and our social institutions, must be made to catch up to the technology that the engineer has created for us. I say that this must be done, that it can be done, and that engineers can lead the way in doing it.—Gwilym A. Price in *Mechanical Engineering* for January, 1954.

Introducing Fertilizer Solutions into High-Pressure Irrigation Systems

E. R. Allred and J. H. Pomroy
Member ASAE Assoc. Member ASAE

MORE favorable price returns during recent years have increased the incentive for farmers to obtain maximum crop yields. Two prerequisites in attaining such yields are (A) heavy application of commercial fertilizers and (B) having a dependable supply of soil moisture. As a result, many farmers have installed irrigation systems and, in order to save both time and effort, are applying fertilizers with the irrigation water.

Commonly Used Methods

The method employed to introduce the fertilizer into the system usually varies with the type of pump. When access can be made to any portion of the suction pipe, as is the case with the ordinary centrifugal pump, the addition of fertilizer solutions is relatively simple. In such cases a pipe (or hose) connection is made from the bottom of the fertilizer container to the suction side of the pump, with a shutoff valve between. An additional pipe (or hose) connection from the discharge side of the pump to the container provides a convenient supply of water for mixing and rinsing purposes.

Whenever deep-well pumps (turbine, submersible, etc.) are used, the suction part of the pump is not readily accessible, since the actual pumping unit is located in the well, at a considerable distance from the ground surface. With such installations, it is necessary to provide some means of introducing the fertilizer solution on the discharge side of the pump, where the pressure may be comparatively high. In some instances the farmer may prefer to introduce the fertilizer into the water after it leaves the pump, regardless of the type of pump being used.

In the past, fertilizer solutions have been introduced into high-pressure lines largely by the use of gear or paddle pumps, or through various constrictive devices. With gear or paddle pumps the fertilizer solution is subjected to a pressure sufficiently high to force it into the high-pressure line. This method, however successful in the past, makes it necessary for the farmer to furnish power to operate the extra pumping unit. Another disadvantage is that additional items of rather specialized equipment must be serviced and maintained.

Venturi sections, aspirators and other constrictive devices, on the other hand, reduce the pressure at a given point in the line to less than atmospheric pressure. When this occurs the fertilizer solution can be admitted into the irrigation water without the need for a separate pumping unit. Such devices may be installed in either the main line of flow or in a branch line running parallel to the main. Venturi sections, installed in the main line and capable of furnishing a sufficient pressure reduction, create a permanent and sometimes serious head loss to the system. Also, due to their special construction and size they are found to be relatively expensive.

Smaller venturi sections, aspirators, etc., are frequently placed in a parallel branch line. By means of regulating valves located in both the main and the branch line, flow is permitted through the branch line only during that period of time the fertilizer is actually being applied. In this manner, the excessive head loss is confined to a much smaller part of the total operation period. Such retardation of flow in the main line, however, may cause a serious decrease in pressure at the sprinklers, during the time in which the fertilizer solution is being applied. This condition results in an uneven fertilizer distribution pattern. Also, the cost of the regulating valve needed in the main line of flow is usually found to be a major item of expense.

Closed Tank Method

The authors have made laboratory and field tests of a relatively simple and inexpensive method of introducing fertilizer solutions into high-pressure lines. A typical hookup is shown in Fig. 1. With this arrangement it should be possible to apply any of the liquid or water-soluble types of fertilizer.

The equipment consists of a water pressure tank, sufficient galvanized iron pipe to extend between two riser pipe openings in the main line (usually 20 ft), three small reg-

This paper was prepared expressly for AGRICULTURAL ENGINEERING. Contributed as Scientific Journal Series Paper No. 3105 of the Minnesota Agricultural Experiment Station.

The authors — E. R. ALLRED and J. H. POMROY — are, respectively, associate professor and instructor of agricultural engineering, University of Minnesota.

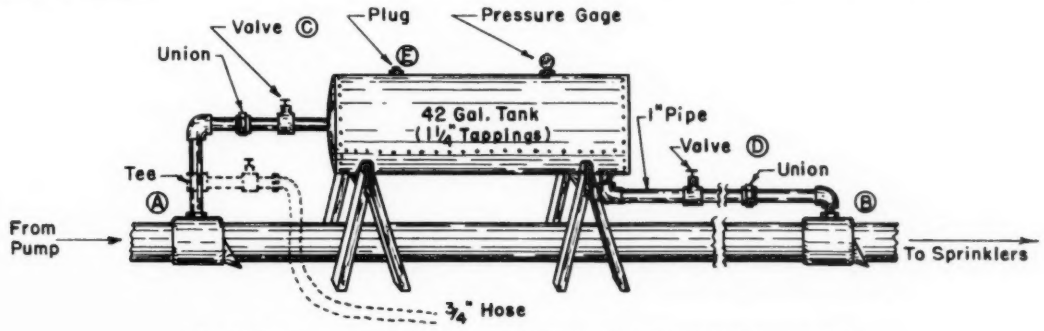

Fig. 1 Equipment setup for introducing fertilizer solutions into high-pressure lines

ulating valves and other miscellaneous pipe fittings. The total cost of this equipment is small with the tank being the only major item of expense. In many cases a good used tank can be obtained to further reduce the cost.

The method operates on the basic hydraulic principle of continuity of flow. This principle merely states that in the case of flow through two parallel pipe lines, such as Fig. 1, the sum of the flow through both branches equals the total flow through the main. Since the pressures at A and B are common to both branches, the head losses in each branch are the same. A head loss occurring between points A and B of the main line causes flow to occur in the fertilizer line. Any fertilizer solution being held in the closed tank is immediately carried into the main line when flow is permitted in the branch line.

The system shown in Fig. 1 is operated by closing valves C and D and removing the 1¼-in plug at E from the tank. No attempt should be made to completely remove the plug from the tank until the pressure gage reads zero. Merely loosening the plug will quickly reduce this pressure. After the plug is removed, the desired amount of fertilizer is poured into the tank by means of a funnel. The tank is then filled with water by opening valves C and D. More favorable mixing of the fertilizer and water is obtained by partially opening both valves. Should the fertilizer fail to dissolve completely some stirring, through the plug opening, may be necessary. After replacing the plug, flow can be started through the fertilizer line by opening valves C and D. Many times it is found that a ready supply of water is desirable for rinsing purposes at the tank. Provision for such can be made by a simple hose connection, as shown in the dotted outline of Fig. 1. Smaller capacity tanks may be used where lesser amounts of fertilizer are being applied. When large amounts are to be applied at a given location of the sprinkler line, it may become necessary to divide the fertilizer and apply it in two operations.

Control of Flow in the Fertilizer Line

The rate of flow through the tank will vary somewhat with the particular setup. By limiting the number of obstructions (such as valves, elbows, etc.) and using the largest possible pipe diameter, flow in the line can be increased. The limiting factors in this respect will depend on the size of the tank connections and riser pipe outlets.

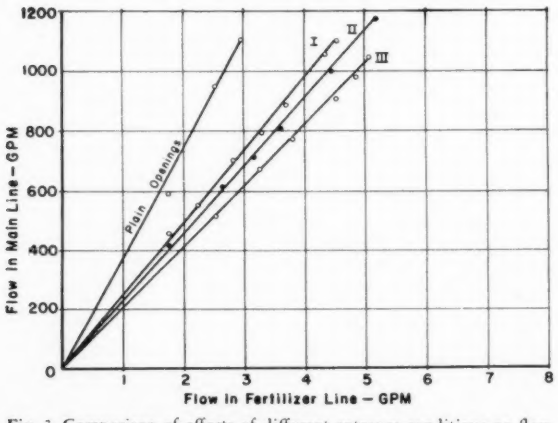

Fig. 3 Comparison of effects of different entrance conditions on flow through fertilizer line

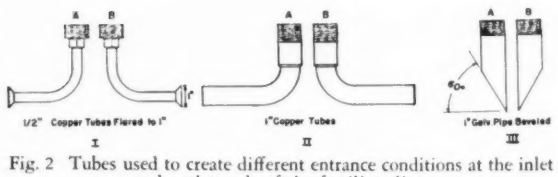

Fig. 2 Tubes used to create different entrance conditions at the inlet and outlet ends of the fertilizer line

A regulating valve placed in the main line between points A and B (Fig. 1) also has an effect on the flow through the tank. Since such retardation of flow in the main line may adversely affect sprinkler pressure, this means of controlling flow through the fertilizer line was not further considered.

Changes in the entrance conditions at points A and B (Fig. 1) also affect the rate of flow through the fertilizer line. Several different entrances were investigated in this study. The most simple condition was with plain pipe openings obtained by connecting the fertilizer branch line directly into the riser outlets. Other studies were made by fitting the inlet and/or outlet ends of the fertilizer line with various shaped tubes. These tubes, shown in Fig. 2, were projected into the center of the main line at points A and B. A comparison of the effects of these various entrance conditions on flow through the fertilizer line is shown in Fig. 3, with the numbered curves (I, II, and III) referring to the tube arrangements shown in Fig. 2. Although a comparable range of head loss should exist for all diameters, the data shown in Fig. 3 was obtained using a 6-in-diameter main line.

Strictly on the basis of the entrance conditions investigated in this study, it appears that for general use entrances with plain openings can be recommended. Fig. 3 shows that with such openings a flow through the fertilizer line of up to 3 gpm can be expected. Since a 6-in-diam main line would commonly discharge 500 to 700 gpm, flow in the fertilizer line will vary from 1.5 to 2.0 gpm. During the earlier stages of this study it seemed that this flow would not be sufficient to expel the fertilizer solution from the

(Continued on page 178)

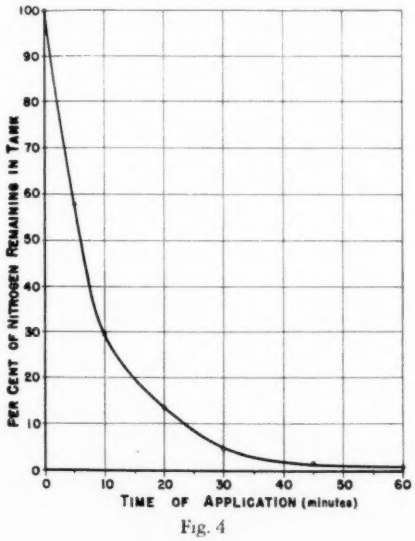

Fig. 4

Some Anomalies in the Determination of Moisture

W. R. Fetzer

THE corn wet milling industry processes annually 125 to 150 million bushels of shelled corn. The corn is obtained largely from country and terminal elevators. The grading of the purchased corn is made at the terminal markets or by a government grader located near a processor's plant. From the wet miller's standpoint the composition of corn, dry basis, is approximately as follows:

Starch	66.8 to 71.5 percent
Crude fat	4.4 to 5.2
Crude protein	9.0 to 10.0
Solubles	4.2 to 5.8

The corn is processed for the separation of starch with coarse fiber, or hull, fine fiber, corn germ, corn gluten and corn solubles or steepwater as by-products. The corn germ is subsequently expressed or solvent extracted, yielding crude corn oil and corn oil meal. The yield obtained from a bushel of 16 percent moisture corn is approximately:

Starch	30.8 pounds
Corn oil	1.7
By-product feeds	14. 5

Part of the recovered starch is dried directly as common or pearl starch or processed and dried as acid modified or oxidized starches. Common starch is often converted to dextrins by roasting with or without catalysts. The remainder of the starch in slurry form is partially acid hydrolyzed to the various corn sirups of commerce, or completely hydrolyzed for dextrose crystallization which yields crystalline dextrose and a final molasses or hydrol. Corn gluten is combined with fine fiber and dried to form gluten meal. Corn solubles, coarse and fine fiber, and corn gluten are combined and dried to form gluten feed. Hydrol may be added to the gluten feed to form a sweetened feed. Thus the laboratories of the wet milling industry are confronted with a variety of moisture problems. Some of the products are relatively heat stabile, others are extremely heat sensitive, and others present difficulty in the removal of the last traces of moisture. As an added complication, the procedure for moisture on the purchase of our raw-material corn is regulated by a federal agency.

The corn wet milling industry has always been concerned with process yields. Briefly, the factory yield is the recovery of dry substances in the form of starch, sirup, dextrose, hydrol, feedstuffs, and corn oil, in comparison to the dry substance corn processed. This yield is not only important from the standpoint of accounting, but it is also a measure of the process loss. It is at once apparent that moisture is an important item in the accounting system. Moisture, or its converse, the determination of dry substance, is not a new problem in the industry. However, the determination of dry substance has undergone some important revisions in the last fifteen years **(2, 3, 4)***. The problem was considered so important that the various refiners pooled their research through the Corn Industries Research Foundation. Most of the research has been published in the various scientific journals, but the full significance of the work has not yet been appreciated outside of the corn wet milling industry.

The determination of dry substance is largely carried out by three methods:

- Oven procedure, either an air or vacuum
- Distillation procedure
- Karl Fischer type.

The oven procedures are strictly loss-in-weight methods, where the loss in weight can be other than water, such as volatiles or volatiles and water produced through decomposition by heat. In many cases, wherever air may cause oxidation of the material, a vacuum oven is employed. The vacuum oven is usually employed when heat labile materials are involved, utilizing lower temperatures. However, vacuum drying may lead to higher losses in weight when the removal of products of decomposition from the system is accelerated by the reduced pressure. The universality of the oven methods, to some extent, rests on the fact that the ovens are common items in any laboratory; more than one sample can be run at a time; and the required skill is easily acquired.

The distillation procedures are old, although this method has had wider acceptance since the introduction of standard taper joints, which eliminated previous closure disadvantages. It has the advantage that the dehydration is made in an inert atmosphere, that water only is measured, and that a large sample may be employed. The disadvantages are that more skill is required, more space per determination, and if water is a product of decomposition, it will be collected as well as the moisture.

The Karl Fischer procedure has not been applied in our industry insofar as I know for the determination of moisture. The disadvantages that have been listed are the expense of the equipment, a still greater skill by the analyst, and the relatively small sample required.

The success of a moisture determination depends not only upon the type of equipment employed, but a careful evaluation of the properties of the material to be tested. In general there are four material types:

(a) Materials which are relatively heat stabile, such as sand, starch, and corn oil meal. Usually these materials can be dried at relatively high oven temperatures employing short periods of time. Since they tend to fracture or pulverize in drying, the increased surface area expedites the drying and thus shortens the time. Such materials work satisfactorily with mechanical moisture apparatus, particularly since it is usually rather easy to correlate values with known moistures.

(b) Materials which are heat sensitive or heat labile. Unfortunately most materials in the food industry fall in this class. The most common reaction is the condensation of an amino group with a reducing sugar to form "browning." Water is liberated in this reaction. Browning is so commonplace in many food products that we often fail to

This paper was presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1953, as a contribution of the Farm Structures and Rural Electric Divisions.

The author — W. R. FETZER — is chief chemist, Clinton Foods, Inc., Clinton, Iowa.

*Numbers in parentheses refer to the appended references.

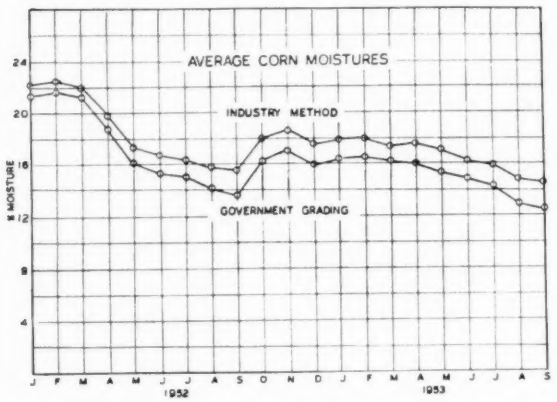

Fig. 1 Underestimation of moisture content of corn by the Brown-Duvel and Tag-Heppenstahl methods

realize that it means some measure of product decomposition. A good example of excessive browning is "burnt" feed.

When the material to be tested is known to contain sugar and soluble protein, special precaution must be taken for a moisture determination. The usual procedure is to carry out the determination at relatively low temperature (70 C) in a vacuum oven or by benzene distillation.

(c) Materials which tend to "caseharden" with heat. Examples of such materials are gluten, yeast, and glues. These materials, even when ground, produce a tough surface film which tends to seal in or delay the release of moisture from the inside of the particle. The usual method of treating such a sample is to disperse it on sand or filter cel, with or without wetting before dispersion.

(d) Materials which tend to flow or concentrate into lumps or masses. Often these materials are extremely heat stabile, suggesting a higher drying temperature in order to reduce drying time. However, the employment of a higher temperature often aggravates the problem, for the higher temperature speeds the flow of the material into agglomerates, from which the final moisture is released with difficulty. The procedure which must be followed in such cases is dispersion on sand or filter cel. In the event the sample is too concentrated or viscous to disperse easily, it may be diluted with a small amount of water to facilitate dispersion. A good example of this type of material is corn sirup which will dry into a piece of hard candy unless the sample is properly dispersed on a suitable medium.

In general, the bulk of the moisture is removed easily by any method. Differences between methods occur in the removal of the last 10 percent of the moisture, for it is in this period of a moisture determination that the final release of the moisture may be impeded through a variety of reasons and false moisture may be produced through decomposition by heat or other causes. It also follows that the percentage differences in results by the various methods will decrease as the moisture content of the sample increases.

This brief general summary of the problems encountered in the determination of moisture has been given to show that a dry-substance determination is not always an easy matter. In fact, it is one of the items of continual variance between the buyer and vendor of many food and feed products. The demand of the equipment and process engineer is for instrumentation. The usual moisture apparatus requires correlation of known moisture values to the instrument readings. Before any such correlation or curve can be made, it is necessary to know the precise moisture content of the product, preferably to a degree that the term "accuracy" may be applied.

As stated earlier, the wet milling industry buys corn and produces starches, sirups, sugars, and feedstuffs. The total industry capacity is of such magnitude that a quick and

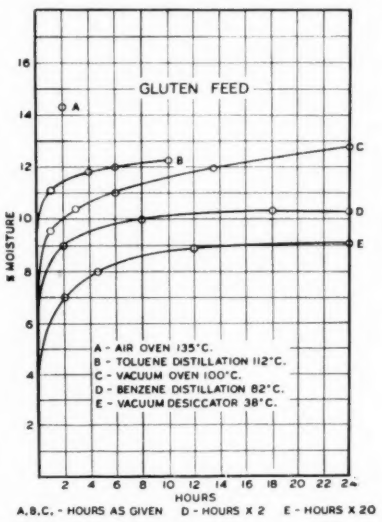

Fig. 2 Data obtained from moisture analysis of a sample of gluten feed by the four AOAC methods and the CIRF method

precise moisture method applicable to all of our products would be of immense value and convenience. However, so far we have been unable to report such progress. I wish to offer in defense two examples which may justify our slowness.

DETERMINATION OF MOISTURE IN CORN

The moisture content of corn is a determining factor in the selling or the purchase price, for it should indicate the amount of dry substance entering the plant. The first moisture method for corn to be accepted as an official procedure was introduced by a botanist near the turn of the century. The drying procedure was relatively simple. Whole kernels of corn were dried in a water-jacketed oven, kept at the boiling point of water for a period of 96 to 120 hr. The loss in weight was termed moisture. I believe it is obvious to everyone that this procedure is slow and the expenditure for ovens would be large if a large number of samples were to be analyzed. In 1907 a distillation procedure based on a petroleum solvent employing whole kernels was devised by Brown and Duvel. This test reduced the time of the moisture determination to an hour. The procedure, however, was standardized to check the water oven method. Attempts to reduce the time for a moisture determination still further resulted in the Tag-Heppenstahl moisture meter. This apparatus was based on the conductivity of the corn obtained by passing the kernels through two rolls maintained at a definite pressure. The Tag-Heppenstahl meter was standardized against the Brown-Duvel procedure.

For some time the laboratories in our industry believed that those methods underestimated the moisture content of corn. In 1937 the industry sponsored research on the mois-

ture content of corn. The work resulted in a method which we believe to be much more precise and accurate. This work was published in 1942.

Briefly, the method consists in drying a weighed quantity of about 100 g to a moisture content of 6 to 10 percent, obtaining the percentage of moisture lost during this drying step. The corn is then ground to pass 10-mesh in an intermediate Wiley mill and the moisture obtained on the ground material by toluene distillation. The moisture of the corn is the sum of moistures obtained by predrying, by loss in grinding, and by toluene distillation. In actual practice in our laboratories, the moisture is determined in a vacuum oven at 113 deg for 18 hr. This oven and pump is reserved for corn samples and is periodically checked against the toluene procedure.

This underestimation of moisture content by the Brown-Duvel and Tag-Heppensthal methods is shown in Fig. 1.

The data shown covers a period of nearly two years. In 1952 the corn as received had a relatively high moisture content. In 1953 the moisture content was considerably lower, occasioned by a dry fall. The underestimation varies from 1 to 2 percent, the larger difference being obtained with the drier corn. The effect of the difference on our factory yield calculations is apparent.

THE MOISTURE CONTENT OF GLUTEN FEED

Gluten feed is a well-known feedstuff produced by our industry. A typical analysis is as follows:

Moisture	11.2 percent
Crude protein	25.2
Ether extract	3.7
Crude fiber	7.6
Ash	8.6
N. F. E.	43.7
Acidity as hydrochloric acid	1.3
pH (10 g to 100 g)	5.2

This analysis is typical of a feedstuff and there is nothing which would indicate that the material would cause difficulty in a determination of the dry substance. However, gluten feed is compounded from corn solubles (steepwater), coarse fiber, and gluten meal. Corn solubles have an approximate dry basis analysis as follows: Crude protein (N x 6.25), 45 percent; reducing sugars as dextrose, 5 to 20 percent; lactic acid, 10 to 30 percent; ash, 15 to 17 percent; pH, 4.2. Corn solubles are heat labile materials as you would expect and it would follow that gluten feed should also be a heat labile material.

The official and tentative methods of analysis of the Association of Official Agricultural Chemists under the section for feedstuffs gives four official methods for the determination of moisture in feedstuffs (1). These methods are, briefly, as follows:

Air oven—135 C for 2 hr.
Toluene distillation—112 C ca 1 hr
Vacuum oven—100 C to constancy ca 5 hr
Vacuum desiccator—38 C to constancy.

The purpose of the vacuum desiccator method is to obtain the moisture content at a temperature normally encountered by the feed itself so that, if decomposition is obtained, it is no greater than is occurring normally. This reasoning is of course based on the belief that water can be removed under these conditions.

A well-equilibrated sample of gluten feed was analyzed for moisture by each of the above AOAC methods and the CIRF official method—benzene distillation. The data obtained are shown in Fig. 2.

Fig. 2 shows that four different answers can be obtained by each of the official AOAC methods. Some idea can be obtained from these data of the confusion that sometimes exists between vendor and buyer over a simple determination of moisture on a common feedstuff.

At first glance, the benzene distillation method would seem to add another value to the four already at hand. However, in the research on moisture methods it was found that, if the weighed sample of gluten feed was first suspended in a small amount of water, the entire mass dispersed on filter cel and then dried in a vacuum desiccator, the moisture results equalled those obtained by benzene distillation. The explanation for this result is quite simple. Gluten feed consists of relatively large particles of fiber on which corn solubles are dried. The film of corn solubles which covers the feed particle seals in the moisture so that a low moisture result is obtained. Once the corn solubles have been dispersed in a medium such as filter cel, the moisture is removed readily at the low temperature of the test. Much of the confusion on the dry substance of feedstuffs occurring between vendor and buyer would be eliminated if the AOAC would list the methods applicable to various types of feedstuffs. Briefly, the dry substance of sweetened feeds, with or without soluble protein concentrates, must be determined by methods other than those presently listed. For a rapid routine or control method, we have found that a close approximation of the moisture content of a gluten feed as determined by the benzene distillation method can be obtained by drying the sample in a mechanically convected air oven at 115 C for exactly 30 min.

This paper so far has dealt with the difficulties in obtaining the moisture content of some common foods and feedstuffs. This emphasis has been given because any instrumentation must be referred to or based on accurate moisture content if it is to be successful. In our industry, moisture meters of the conductivity type are employed for common starch, gluten meal, and soya meal. Common starch is defined as ordinary food or pearl starch. This type of moisture meter does not work on acid modified or oxidized starches, for these starches contain variable amounts of ash from the chemicals used for modification, which renders any meter reading unreliable. Moisture meters of the dielectric type have been successful on gluten meal and soya meal and partially successful on gluten feed, which has a variable composition with respect to the ingredients in compounding to 23 percent minimum protein content.

The problem of an instantaneous moisture meter which would determine moisture per se in any material is intriguing and the economic importance of such an instrument would warrant a considerable expenditure for research. This problem was given to the Southwest Research Institute at San Antonio, Tex. Their approach to the moisture determination is by nuclear magnetic resonance. The amplitude of the resonance signals is determined primarily by the number of hydrogen nuclei present as adsorbed water, but it is also influenced by the concentration of paramagnetic impurities in the aqueous phase and by the manner in which the water molecule is held by the adsorbed material.

(Continued on page 178)

Potato Storage Ventilation

J. W. Layer, L. L. Boyd, and B. C. Haynes, Jr.
Affiliate ASAE Member ASAE Assoc. Member ASAE

LONG ISLAND, New Jersey, and eastern Pennsylvania with their large metropolitan areas is a potato deficit region. However, the climate is suited to the production of an intermediate crop. Even though this area is a potato deficit region, a large proportion of potatoes are shipped out of the area at harvest time. This is due to the lack of proper storage facilities and to a short harvest period of approximately ten weeks during which the market is overloaded. In addition, late shipments from early-crop potato states tend to aggravate this market overflow.

An economic study of the potato-marketing situation will justify the construction of storage facilities. Markets will vary yearly tending to reflect a number of conditions such as total production, expenses, storage and consumption. Storage which lengthens the market season and eliminates unnecessary transportation will assure the producer of a more stable market. Storage should also help to assure the consumer of adequate food at reasonable prices throughout the year.

Storage offers another advantage. Generally speaking, smaller crews may be utilized in harvesting potatoes into storage than for immediate sale, and these crews may be employed more steadily throughout the season. There is less dependence on transportation facilities and more food is available within the area in the event of disaster.

This paper deals with the ventilation phase of white potato storage and marketing investigations in New Jersey, Long Island and Pennsylvania, on which the Division of Farm Buildings and Rural Housing of the U.S. department of agricultural and the state agricultural experiment stations of New Jersey, New York and Pennsylvania are cooperating. This project became effective February 17, 1949, and still continues. The work is at present being shifted from the New Jersey Agricultural Experiment Station at New Brunswick to the Long Island Vegetable Research Farm at Riverhead, Long Island.

RECOMMENDED STORAGE CONDITIONS

Potatoes can be kept sprout free at 50 F for 3 to 4 months following maturity whether matured in field or storage. In order to store potatoes successfully over a period of 6 to 9 months, it is necessary that certain recommended storage conditions be met. White potatoes intended for table stock should be maintained at a temperature of 40 F and at a relative humidity in the range of 85 to 90 percent.

At temperatures below 40 F there is a tendency for potatoes to become undesirably sweet, a condition which is partially overcome by exposure to temperatures in the range of 70 to 80 F for a period of about two weeks. At 40 F white potatoes will remain dormant for 6 to 9 months, depending upon the variety. Potatoes stored at 50 to 60 F will have the best texture, color, and flavor when cooked or made into chips, but can be stored only 2 to 4 months.

A relative humidity of 85 to 90 percent is necessary to maintain shrinkage rates at a minimum. Higher relative humidities are undesirable since they frequently result in condensation. Condensation on storage walls and ceilings must be avoided to preserve the storage structure and to prevent wetting of the potatoes.

Seed stock which is to be held for periods of 6 to 9 months will store satisfactorily under the same storage conditions recommended for table stock. If table or seed stock is to be held for longer periods, storage temperatures should be reduced to 36 to 38 F.

Under average weather conditions, it is possible to maintain the following temperatures in well constructed, properly ventilated, unrefrigerated storages located in this area: Early October to early November, 50 to 60 F; early November to midNovember 40 to 50 F; midNovember to mid-March, 40 F.

It is not uncommon for storage temperatures to rise 10 F during a week of unseasonably warm weather in the middle of the storage season. If outside temperatures average 55 F and prohibit ventilation for a total of 4 days, storage temperatures may be expected to rise from an average of 40 F to an average of 50 F. Short periods of warm weather that raise temperatures above the desired temperature have little effect on long-term storage.

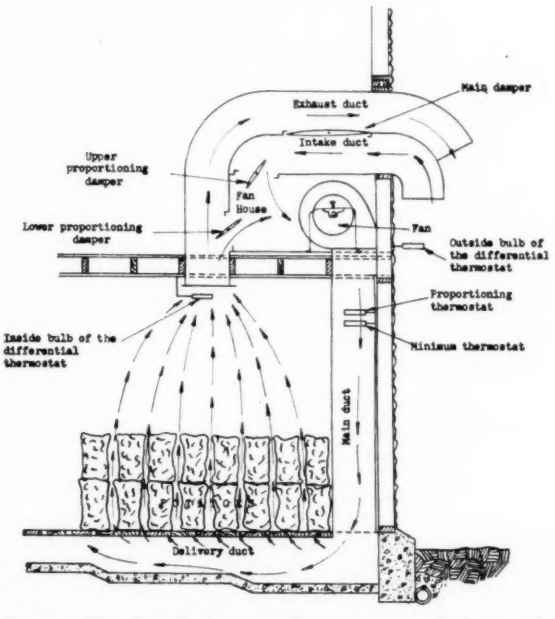

Fig. 1 Section through the proportioning system with dampers in position for proportioning

This paper was presented at a meeting of the North Atlantic Section of the American Society of Agricultural Engineers at Farmingdale, L. I., N. Y., August, 1953.

The authors—J. W. LAYER, L. L. BOYD, and B. C. HAYNES, JR.—are, respectively, district agricultural engineer and associate professor of agricultural engineering, New York State College of Agriculture, and associate agricultural engineer, U.S. Department of Agriculture.

Acknouledgment: The authors gratefully acknowledge the assistance of Wallace Ashby, A. D. Edgar and R. S. Claycomb in the preparation of this paper. Mr. Claycomb, associate agricultural engineer, USDA, analyzed the shortcomings of the two-position damper system. B. C. Haynes, Jr., suggested and developed the "proportioning system" of ventilation and made the initial tests.

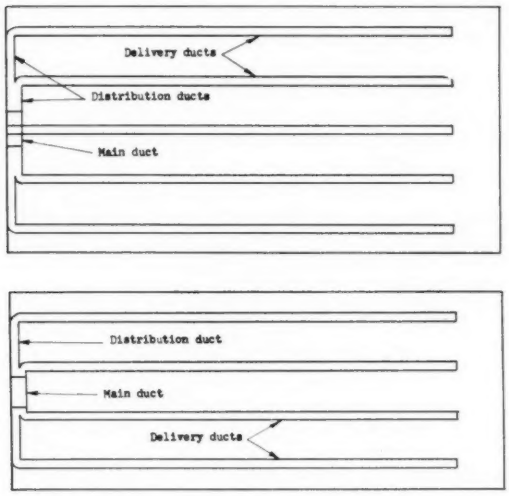

Fig. 2 *(Top)* Duct layout for a system with 5 delivery ducts. *(Bottom)* Duct layout for a system with 4 delivery ducts

VENTILATING SYSTEMS

Ventilation systems for common potato storage can be classified as either gravity or forced air. They can be further subdivided into shell-cooled or through-cooled. The gravity system usually utilizes wall ducts along the outside wall in which the air drops and moves under the pile through small ducts and up through the potatoes. Successful cooling is achieved with this system only when the outside temperature is considerably cooler than that within the storage. Shell-cooling can be used with the gravity system in the colder climates where there is less field heat in the potatoes at storage time.

Forced-air cooling can be accomplished either by through cooling or by shell-cooling. In areas where harvest is carried out in extremely warm weather, and the potatoes have a considerable amount of field heat, it is necessary to use through-cooling to reduce the potatoes to the desired storage temperatures in the shortest possible time. In cooler climates, forced-air shell-cooling probably is satisfactory but it does require more duct construction than does the through-cooling.

The first studies at the New Jersey Agricultural Experiment Station with forced-air, through-cooling were accomplished with a two-position system. This system is arranged to deliver outside air to the storage or to recirculate the air within the storage. A damper is rotated by a two-position damper motor which is controlled by a differential thermostat and a minimum thermostat wired in series. The differential thermostat causes the damper motor to rotate the damper to admit outside air for ventilation when the outside air is cooler than the storage air. It causes the damper to rotate for recirculation when the reverse is true. The minimum thermostat causes the damper to be rotated for recirculation whenever the first potatoes affected by ventilating air are cooled to a set minimum. Recirculation of relatively warmer air at the minimum thermostat warms the potatoes at this point, resulting in a ventilation cycle. Air circulation during both the ventilating and recirculating cycles results in more uniform temperatures throughout the storage. Continuous recirculation does not appear to be necessary, and for this reason a time clock operates the fan at intermittent intervals, usually 15 min per hr.

The two-position damper system*, although a considerable improvement over other types, requires increased fan output to provide adequate ventilation during mild winter weather. Heat-removing capacity at 18 F outside air temperature is about one-half as much as at 32½ F when potato temperatures are at 40 F. The reduced heat-removing capacity at a fixed fan output is caused by rapid cooling and slower warming of the minimum thermostat bulb. Thus the ventilation periods become shorter and recirculation periods become longer until low outside air temperatures prevail. At 5 F the system will again remove as much heat as at 32 F. The economy of reducing fan speeds during winter months, as is done in colder areas, cannot be realized in the more temperate areas.

Due to this shortcoming of the two-position system a further development was made in the form of the "proportioning system". This system (Fig. 1) in addition to the two-position damper for ventilation and recirculation has two small proportioning dampers which mix outside air and storage air at the proper temperatures so as not to cause freezing. This system does not have the reduced cooling capacity of the two-position system. The proportioning thermostat will cause the dampers to move so as to admit some air colder than 32 F continuously and to mix it with storage air. The temperature of the resulting air mixture is controlled by a proportioning thermostat. This obviously makes the system more complicated, but also makes it far more satisfactory.

A further development of the proportioning system is the use of a proportioning motor on the main damper, eliminating the two smaller proportioning dampers. This proportioning damper motor should be equipped with spring return to close it in case of power failure so that cold air will not settle into the storage and result in freezing of potatoes. The single damper with a proportioning motor, rather than a two-position spring-return motor, has not been tried in this area other than on an experimental basis. However, a single-damper proportioning system is being installed in several storages for operation this season.

*R. S. Claycomb, associate agricultural engineer, U.S. Department of Agriculture, analyzed the shortcomings of the two-position damper system and suggested use of the proportioning system.

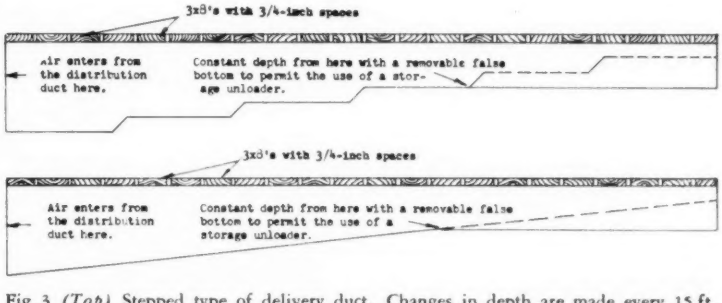
3x8's with 3/4-inch spaces
Air enters from the distribution duct here.
Constant depth from here with a removable false bottom to permit the use of a storage unloader.
3x8's with 3/4-inch spaces
Air enters from the distribution duct here.
Constant depth from here with a removable false bottom to permit the use of a storage unloader.

Fig. 3 *(Top)* Stepped type of delivery duct. Changes in depth are made every 15 ft. *(Bottom)* Sloped type of delivery duct. The bottom has a constant slope from one end of the duct to the other

DESIGN FACTORS

Any potato-storage ventilation system must be well designed if it is to function properly. Studies at the New Jersey station show that 1 cfm of air per 150 lb of stored potatoes is adequate. Before the fan size can be determined, it is necessary to know the static pressure at which the fan must operate. Potatoes are assumed to have about the same resistance to air flow as that of ear corn. This may vary from ⅛ up to ½ in static pressure. We will assume that this resistance of potatoes is approximately 0.25 in for a pile averaging 10 ft in depth. A considerable amount of frictional resistance is built up in the duct system which supplies the air to the potatoes. In general, the fan should deliver the required amount of air at a static pressure of ⅜ in for volume of air up to 8,000 cfm, at ½ in for volumes from 8,000 to 14,000 cfm, and ⅝ in for volumes from 14,000 to 20,000 cfm. The centrifugal fan has generally been used because of ease of installation.

The necessary duct design should be computed as recommended by the American Society of Heating and Ventilating Engineers in their ASHVE Guide. An air velocity in the main duct of 1200 fpm seems desirable with a reduction to 1000 fpm in the distribution ducts and 800 fpm at the mouth of the delivery ducts. Delivery ducts are usually made 20 in wide to accommodate storage unloading equipment. The depth can be computed using either the "equal friction" or the "static regain" methods.

Distribution ducts should be the same depth as the inlet end of the delivery ducts. With certain storage layouts where heavy traffic must pass over the distribution duct, it may be desirable to increase the depth and decrease the width.

The main duct may be any shape that fits well into the storage, but should be about the same depth as the width of the distribution duct. Insulation of the main duct is necessary to prevent condensation, if this duct is not a floor duct.

Fan house design must provide sufficient room for the fan and motor. Allow at least a fan diameter between the inlet and the wall so as not to cause inlet restriction. The fan house should be insulated as well. Openings in the fan house for dampers should be large enough for free movement and should be weatherstripped to reduce air leakage. All dampers should be mounted in self-aligning bearings for freedom of movement.

In selecting the controls, several things must be kept in mind. Voltage ratings are only of importance where thermostats and damper motors function as a unit. In selecting thermostats check the temperature range, open and closed circuit relationship and the operating differential. Damper motors must be selected for direction of rotation and the maximum damper area for which they are designed.

A low-amperage time clock to operate a cross-the-line starter for periods of recirculation should also be selected.

RESULTS AND CONCLUSIONS

Ten systems were installed on Long Island and three in upstate New York in 1952. At least ten more systems will be put in operation in 1953. While more use will undoubtedly be made of the porportioning system in climates similar to Long Island, forced ventilation has merit elsewhere.

Research and field experience is still too limited to evaluate the over-all effectiveness of the proportioning system. All farmers who have used the system feel that there was at least some improvement in storage conditions.

While more information is needed, it is now known that potatoes can be stored safely from September until April and possibly even later. The proportioning system is certainly a step forward in potato-storage ventilation in this area.

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Fertilizer in Irrigation Systems

(Continued from page 172)

tank at a proper rate. Chemical analyses of samples taken at specified time intervals, following the beginning of flow through the tank, indicate that a large flow is not required in the fertilizer line. The results of such analyses are shown in Fig. 4. Having a greater specific gravity than water, the fertilizer solution has a tendency to settle toward the bottom of the tank. Since the outlet is also located at the bottom of the tank, the high concentrations of fertilizer solution leave the tank during the early part of the operation. It is noted from Fig. 4 that even though the tank flow was but 2 gpm, approximately 95 percent of the nitrogen originally placed in the tank entered the main stream within 30 min. The results of such tests indicate that the fertilizer solution is expelled in a relatively short time, even though the flow through the tank may be very small.

Determination of Moisture

(Continued from page 175)

Their present apparatus utilizes a large air-core solenoid providing a magnetic field of 235 gauss. The precision with which moisture can be determined at 235 gauss is somewhat poorer than that obtainable at magnetic fields of several thousand gauss. The usual sample size is 50 ml although samples as large as 700 ml have been employed. The significance of large samples is immediately apparent, for it eliminates to a very large extent the preparation of a small sample required for the usual laboratory determination of dry substance. The progress of the work so far indicates that it may be possible to measure continuously the moisture content of a material in process. If the moisture content of material can be indicated rapidly and continuously, it can be integrated with a recording device. Thus the dream of every process engineer and operating supervisor becomes a reality.

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NEWS SECTION

The ASAE Southeast-Southwest Section Officers

SEPARATE business sessions of the Southeast and Southwest Sections of the American Society of Agricultural Engineers, during their joint meeting, in conjunction with the annual convention of the Association of Southern Agricultural Workers at Dallas, Tex., February 1 to 3, included elections of officers.

Harold D. White, professor of agricultural engineering, University of Georgia, Athens, is the new chairman of the Southeast Section. The new vice-chairmen are A. W. Cooper, project supervisor, U.S. Soil Conservation Service, Auburn, Ala., and R. P. Kay, Douglas Fir Plywood Assn., Memphis, Tenn. Rex F. Colwick, regional cotton mechanization project, State College, Miss., is the new secretary.

A. H. Gray, Jr., head, rural development dept., Southwestern Gas and Electric Co., Shreveport, La., was elected new chairman of the Southwest Section for the coming year. Wiley D. Poole, agricultural engineer, Louisiana Agricultural Experiment Station, is the new vice-chairman, and Xzin McNeil, associate professor of agricultural engineering, University of Arkansas, was elected the new secretary of the Section.

The meeting program developed as scheduled. At the joint Section dinner, Tuesday evening, February 2, R. H. Driftmier was the toastmaster. Edwin W. Tanquary, president of ASAE, was the principal speaker. Group singing, led by E. B. Doran, showed numerous willing and some cultivated voices in the group.

Michigan Section Program on Heat Pump

MORE than 50 members and guests of the Michigan Section of ASAE attended its meeting at Jackson on February 13.

Opening feature of the day was a trip to the plant of Acme Industries, manufacturer of heat-pump heating and air-conditioning units. After seeing the manufacturing operations and the product in the showroom, the group drove to nearby Michigan Center to see an installation in a branch of the National Bank of Jackson, which is heated and air conditioned entirely by Acme Flow-Temp units.

During a luncheon at the Hayes Hotel, W. G. Buchinger, Section chairman, announced that two members of the group, Carl W. Hall and Theodore J. Brevik, had in the past year taken and passed the Michigan examinations for registration as professional engineers.

J. P. Ditchman, illuminating engineer, General Electric Co., was the opening speaker on the program. He showed and commented on colored slides illustrating experimental applications and effects of light in various combinations of wave lengths, intensities and exposure times, on a variety of crops.

Trends in corn culture, a subject discussed by Harris Gitlin, research engineer, Tractor and Implement Division, Ford Motor Co., emphasized new approaches to corn production aimed at reducing production cost and improving the operation from a soil conservation standpoint.

Harold E. Pinches, product and field research engineer, Harry Ferguson, Inc., talked on limited tillage for corn.

A progress report on the effect of accelerated electrons on wheat, flour, and beans, and on certain insects that infest these products was presented by D. E. Wiant, Michigan State College.

ASAE Meetings Calendar

March 13—OHIO SECTION, Standard Oil Refinery, Lima, Ohio

April 1 and 2 — PENNSYLVANIA SECTION, Agricultural Engineering Building, Pennsylvania State University, State College.

April 2 and 3—MID-CENTRAL SECTION, Robidoux Hotel, St. Joseph, Mo.

April 2 and 3 — ROCKY MOUNTAIN SECTION, Colorado A. and M. College, Fort Collins

April 9 and 10 — GEORGIA SECTION, Tidewater Conservation Experiment Station, Fleming, Ga.

May 14 and 15 ALABAMA SECTION, McLester Hotel, Tuscaloosa, Ala.

June 20-23—47TH ANNUAL MEETING, University of Minnesota, Minneapolis

August 24-26—NORTH ATLANTIC SECTION, University of Vermont, Burlington

October 14 and 15—PACIFIC NORTHWEST SECTION, Davenport Hotel, Spokane, Wash.

December 6-8 — WINTER MEETING, Edgewater Beach Hotel, Chicago.

NOTE: Information on the above meetings, including copies of programs, etc., will be sent on request to ASAE, St. Joseph, Mich.

Program on Farm Uses of Petroleum

THE next meeting of the Ohio Section of the American Society of Agricultural Engineers will be held at the refinery of the Standard Oil Co. at Lima, Ohio, on March 13, and will feature the farm uses of petroleum.

The program will open with a history of the refining process which will be followed by a tour of the refinery. Three papers are scheduled for the afternoon session beginning with one on the "Magic Barrel" followed by one on lubricants for farm power units, and the third on greases — all to be prepared by automotive engineers on the refinery staff.

Rocky Mountain Section Program

THE program which the Rocky Mountain Section of the American Society of Agricultural Engineers will present at its next meeting, April 2 and 3, on the campus of the Colorado A. & M. College at Fort Collins includes the following subjects and speakers: New developments in fuels and lubricants by C. N. Hinkle, Standard Oil Co.; application of forced ventilation to crop preservation by Geo. R. Shier, Aero Supply Co.; recent evaporation and transpiration studies by Walter Garstka and Earl Harbeck, USBR and USGS engineers; new developments in tractors and tractor testing by L. F. Larson, Nebraska Tractor Testing Laboratory; European agriculture by H. W. Dahlberg, Great Western Sugar Co.; the utilization of power to avoid peaks by E. R. McEven, Public Service Company of Denver; water application efficiencies by V. E. Hansen, irrigation engineer, Utah State Agricultural College; water conveyance structures for farms by Carl Wilder, Portland Cement Assn., and how *not* to present a technical paper by Ivan D. Wood, USDA irrigation engineer.

This picture represents about half the group of ASAE members who attended the meeting of the Society's North Carolina Section held January 22 and 23 on the North Carolina State College campus at Raleigh

NEWS OF ASAE MEMBERS

Ralph C. Hay is now on leave from his position as professor of soil and water engineering, University of Illinois, to accept a two-year assignment at the Indian Institute of Technology, Kharagpur, West Bengal, India. In this assignment his principal responsibility will be to set up and head a new department of agricultural engineering at that institution. The Institute, which is an activity under the Indian federal government, is operating under a cooperative agreement with the University of Illinois. It has been in operation for three years, and the plan for an agricultural engineering department was first admitted in 1953. Mr. Hay will be responsible for organizing the department staff and developing instructional courses in an agricultural engineering curriculum. A research program will also be developed on the Institute's land.

David B. Poor recently announced organization of the David Poor Company, at Warsaw, Ind., to handle farm buildings and equipment and provide a consulting service to farmers in that area. Simultaneously the

Stran-Steel Products Co., Terre Haute Div., announced appointment of the David Poor Company as its authorized dealer for Warsaw and vicinity. Officers of the new organization will be located in the First National Bank Building in Warsaw.

Edward H. Wiser, a 1953 agricultural engineering graduate of Iowa State College, has accepted a position as graduate assistant in the agricultural engineering department, North Carolina State College, Raleigh.

Harold Holmen has resigned his position in construction engineering work with the Bureau of Reclamation, USDI, to become research assistant in agricultural engineering at his alma mater, South Dakota State College, Brookings.

David S. Moore recently changed positions, leaving his former work as manager of the Montague, Calif., Water Conservation District to become watermaster for the Glenn-Colusa Irrigation District at Willows, California.

Willard C. Cleland is now employed with Harry Ferguson, Inc., and may be addressed at 8027 Bingham, Detroit 28, Mich. He returned last August from two years of service with a U.S. Army engineer combat battalion in Korea.

Vilas V. Johnson, formerly president of the American Equipment Distributors, Inc., is now president of the American Crop Drying Equipment Co., Crystal Lake, Ill.

Chris Nyberg retired February 1 as chief engineer at Plant No. 1 of The Oliver Corp., at Battle Creek, Mich. He is a veteran in the engineering development and improvement of grain-harvesting machinery, having worked in that field almost continuously since 1910 when he was employed as a mechanic in the engineering department of the Advance-Rumely Co. He has been at the Oliver Battle Creek plant since 1934. His future plans include maintaining his home at 4 Pioneer Ave., Battle Creek, and continuing work in his field on a consulting basis.

Chris Nyberg

W. W. McLaughlin, Honorary Member of ASAE and John Deere medalist, former chief of the division of irrigation engineering and water conservation, Soil Conservation Service, USDA, and now consulting engineer to the Service, was elected an honorary member of the Soil Conservation Society of America, at its annual meeting in 1953.

Leonard D. Kimmel has resigned as agricultural engineer in design and development work for the Freeman Mfg. Co. to accept a position as supervisor in the finishing department of the New Holland Machine Co. at Belleville, Pa.

Harold L. Winterfeld recently resigned as veteran's instructor in farm training in the city schools of Milbank, S.D., to accept a position as public relations and power-use advisor with the Nobles Electric Cooperative at Worthington, Minn.

J. R. Caverhill, who has been serving as assistant director of the land clearing division of the department of agriculture of the Province of Alberta in Canada, has left for the Far East to take an assignment under the Colombo Plan auspices. He will be located in the office of the Canadian government high commissioner at Karachi, W. Pakistan.

Robert N. Robinson, who has been employed as an agricultural engineer with the U.S. Department of Agriculture, located at Purdue University, Lafayette, Ind., has gone to farming and is located at Marion, Ohio. In addition to his farming activity he will also be an authorized dealer of a line of crop-drying and storage equipment.

Eugene C. Brown, Jr., has resigned as a member of the agricultural engineering staff of the A. and M. College of Texas, to accept employment with the G. A. Kelly Plow Co., Longview, Tex., as an engineer on design and development work.

Robert E. Moore recently left for Peru where he will be employed as an agriculturist on a million-acre road building and colonization project. He will be in the employ of LeTourneau Del Peru, Inc., Tournavista, Peru.

NECROLOGY

Glenn A. Cumings, a member of agricultural engineering research staff in the U.S. Department of Agriculture for the past 27 years, passed away suddenly February 6, at his home in University Park, Md. He was 59 years old.

Born on a farm near Wayland, Iowa, he obtained a bachelor of science degree in agricultural engineering from Iowa State College in May, 1917. From 1917 to 1918 he was an instructor in farm machinery at the University of Wisconsin. During World War I, he served in the Navy for about a year as chief of mechanical materials at the Great Lakes Naval Training Station, Great Lakes, Ill. After his discharge from the Navy in 1919, he became associate professor of farm mechanics at Colorado A. & M. College until 1922. From 1922 until 1927, when he joined the USDA agricultural engineering staff, he was assistant in mechanical engineering at the Colorado Agricultural Experiment Station.

In this capacity he conducted some of the pioneering research on methods of handling hay, protection of stacked hay, humidification of air in buildings, and use of carbon dioxide gas as a fire extinguisher.

His work in the USDA since 1927 has been devoted largely to research on the mechanical placement of fertilizers. He earned recognition as a leader in this field, with the fertilizer and farm equipment industries as well as in the U.S. Department of Agriculture and among other agricultural engineers.

A member of ASAE since 1918, he served for many years as chairman of its Committee on Fertilizer Application, and chairman of its group of representatives on the National Joint Committee on Fertilizer Application. His work as chairman included taking his turn every three years in planning a program for a meeting of the National Joint Committee in cooperation with the Power and Machinery Division of ASAE. His work spanned the years from early recognition of the economic importance of placing fertilizers where they would be most beneficial to the atomic-age phase of using radioactive tracers to measure the effect of placement on crop yields.

G. A. Cumings

In 1953, when the Society was elected to affiliated membership in the American Association for the Advancement of Science, and authorized to appoint a representative to serve on its Council, Mr. Cumings was appointed to represent ASAE. In this capacity he had attended the 120th annual meeting of the Association in Boston, December 26-31, 1953, and provided a report published in AGRICULTURAL ENGINEERING for February, 1954.

He was also a member of Gamma Sigma Delta, and had recently served as a deacon of the Riverdale Presbyterian Church, Riverdale, Md. Following funeral services at that church, February 9, he was returned to Iowa for burial. He is survived by his widow, Winifred, two sons, a daughter, and two sisters.

• • •

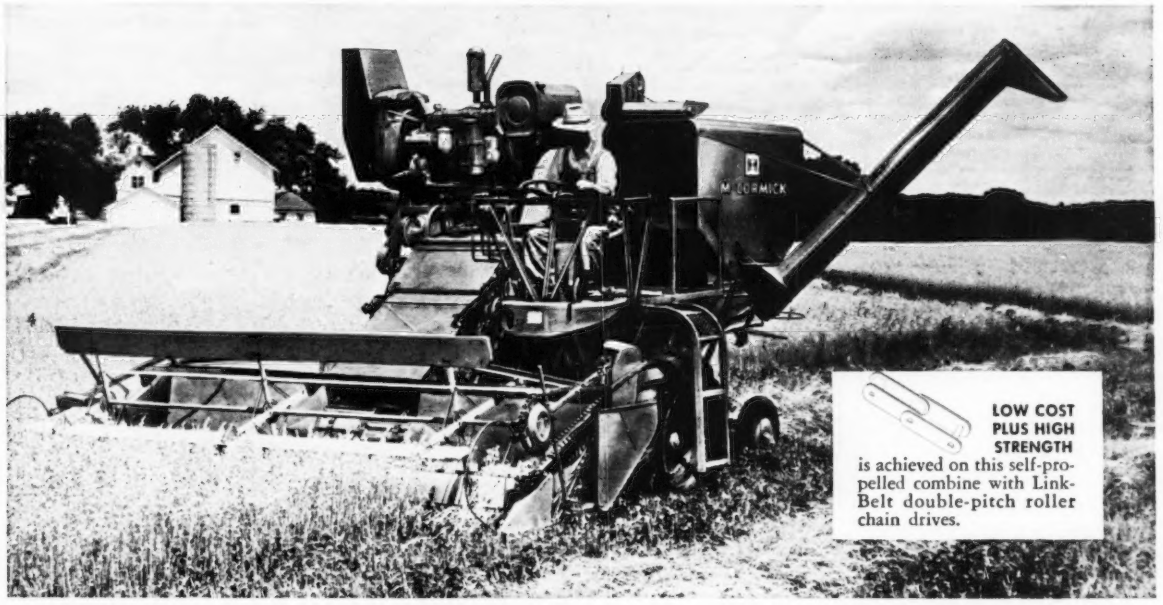
Elmer R. Meacham passed away at his home recently, after a short illness. He was methods engineer for the Wisconsin Power and Light Co., and an advisory editor of "Electricity-on-the-Farm" magazine.

Born at Brodhead, Wis., in 1889, he attended the Dunn County school of agriculture for two years and the University of Wisconsin. At the University, after a war-service interruption, he earned his BS degree in 1920, with a major in agricultural engineering and an MS degree in agricultural engineering in 1924. During his senior year in college he was a student assistant in the agricultural engineering department. Following his graduation he went to Clemson College, S. C., as assistant professor of farm machinery, in the agronomy department. In this capacity he was in charge of all of the agricultural engineering work handled by the College. He planned and taught courses, helped revise the curriculum, selected new equipment and texts and carried on some extension work. Returning to Wisconsin in 1922 as a graduate assistant, he taught short-course classes and helped on drainage extension work. During the summer of 1923 he conducted a concrete tile investigation in the field, in cooperation with a representative of the U.S. Department of Agriculture.

His first connection with rural electrification came in 1924, when he was named project leader for the Wisconsin Committee on the Application of Electricity to Agriculture. He had charge of and did much of the actual work in the development and installation of the Ripon experimental electric power line. This led to his appointment in 1925 to head the rural service department of the Wisconsin Light and Power Co. He continued with the Company in this and broader capacities until his passing.

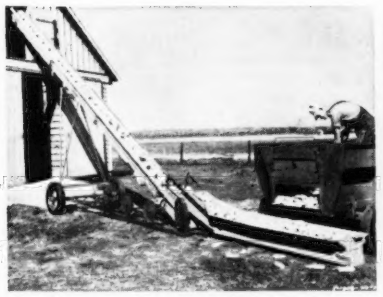
As a member of ASAE since 1920 and a worker in various utility associations he exerted a quiet but firm national influence for the development and progress of rural electrification on a sound engineering basis. He was preceded in death a few years ago by his wife who shared his professional interests and was a well-known writer on the use of electricity in farm homes.

Is there ONE chain that's best for your drive or conveying job?

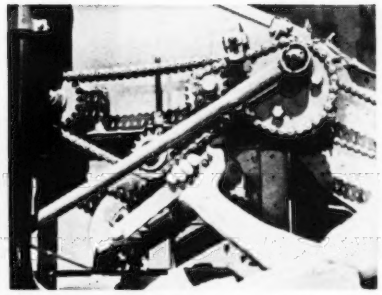


LOW COST PLUS HIGH STRENGTH is achieved on this self-propelled combine with Link-Belt double-pitch roller chain drives.

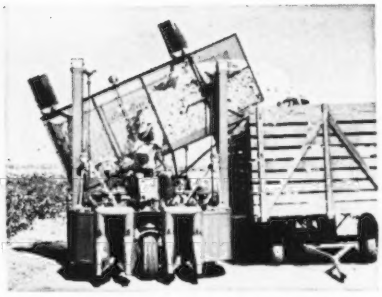
YES! And you'll find the answer in LINK-BELT's complete chain line . . . a size and type for every job



LIGHTWEIGHT, ECONOMICAL Steel Link-Belt is used to elevate ears of corn on portable elevator.



SHOCK AND IMPACT are no hazard for Link-Belt roller chain. This combine also uses Link-Belt augers.



BOTH DRIVE AND CONVEYING functions are performed on this cotton picker by Steel Link-Belt and Link-Belt roller chain and sprockets.

Follow the example of more than 400 farm machinery manufacturers--for your complete drive and conveying chain needs, rely on . . . LINK-BELT

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CHAINS and SPROCKETS

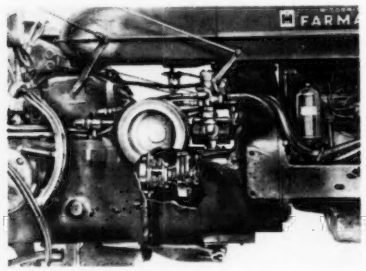
LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Offices: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

NEW PRODUCTS CATALOGS

Tractors with Torque Amplifiers

International Harvester Co., Chicago, Ill., announces two new tractor units to be equipped with torque amplifiers. They will be known as the Farmall Super M-TA and McCormick Super W6-TA tractors. Technically a torque amplifier is a planetary-gear speed-reduction unit installed in the clutch housing between the engine clutch and the regular five-speed transmission. It is controlled by a lever reached from the driver's seat.

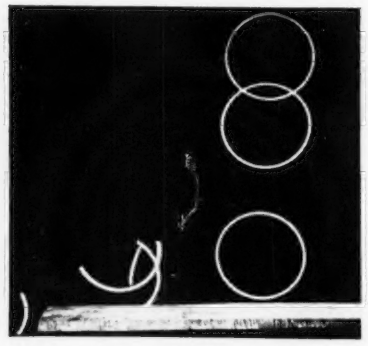
The torque amplifier affords five additional forward speeds and one additional



reverse speed, giving a total of ten forward and two reverse speeds. With the device the tractor operator can instantly reduce travel speed and increase pulling power in any gear without stopping, without declutching, without shifting and without touching the throttle. The power flow to the rear wheels is automatic and uninterrupted. With this device smooth non-stop turns can be made at the end of rows and fields simply by pulling back the control lever. This action reduces the speed making the turn easy. Starting loads in high gear is made easier by reducing the starting speed to 11 mph.

Ductile Iron

The accompanying stroboscopic photograph shows two cast-iron pipe sections dropped from a height of 20 feet, shortly after contact with a steel plate. The gray-iron section broke into pieces while the ductile iron section (right) shoots upward in a bounce pattern. Ductile iron, a development of The International Nickel Co., is a new cast iron which is not brittle and can be bent or twisted. This product has several

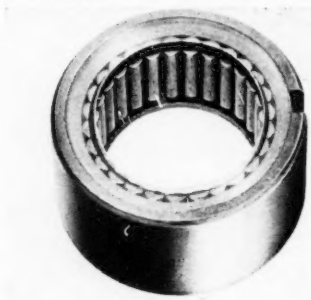


times greater strength than ordinary cast iron together with ductility and shock resistance. Ductile iron is a magnesium-containing iron having spheroidal graphite in a broad range of matrix structures. It responds to thermal treatment in a manner similar to steel. Also it is weldable with techniques which are applied to gray iron.

Cam-Type, One-Way Clutch

Morse Chain Co., 7601 Central Ave., Detroit 10, Mich., announces a new line of cam-type, one-way clutch units designed to serve as backstop (antirotation), indexing and overrunning clutches in a wide variety of machine drives. These units are known as 200 Series Morse Cam Clutches and are made with OD dimensions and tolerances corresponding to seven sizes of standard 200 Series ball bearings. The clutches have no inner race; the full complement of cams bear directly on a hardened shaft surface. Thus individual clutch units can be mounted in a machine housing bore adjacent to the ball bearing supporting the shaft on which the clutch acts.

These cam clutches are unit assemblies consisting of a hardened steel outer race, hardened ball bearing steel full-complement cams, two steel energizing springs, two spring-steel thrust washers and two soft-steel retaining plates. The cam and energizing spring assembly and two steel thrust washers are retained in the keywayed outer race by two soft steel washer-shaped plates, one on each side of the outer race. These washers are staked in position. Cams and energizing springs can be replaced without removing the retaining plates. Typical machinery applications include speed reducers,



speed changers, gear motors, variable-speed drives and power drives in such equipment as conveyors, materials-handling equipment, hoists, winches, pump systems operating against heads and related applications where reverse-drive rotation must be prevented.

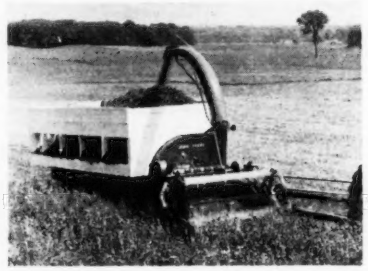
New Four-Wheel Tractor

Caterpillar Tractor Co., Peoria, Ill., pioneer of the track-type tractor and this year celebrating the 50th anniversary of track-type power, machine, announces a new 150-hp four-wheel tractor. The tractor, designed for principal use with scrapers and wagons, includes wagon controls and windrow breaker. The tractor is equipped with standard transmission which gives double speed ranges, with ten forward speeds up to 24 mph and two reverse speeds up to 3.3

mph. Optional final drive gears make possible speeds up to 31.3 mph. Large capacity wheel brakes are foot-pedal controlled and have compressed air boosters. When brakes are applied, those on the pulled unit are actuated automatically just before the prime mover brakes take hold, to avoid jacknifing. The flywheel clutch has an air booster which reduces clutch-pedal pressure when engaging and disengaging the dual, 16-in metallic clutch plates. The unit is powered by a six-cylinder diesel engine.

New Forage Harvester

John Deere, Moline, Ill., announces its new No. 8 forage harvester, a completely new machine with three interchangeable harvesting units—mower bar, row-crop unit, and windrow pickup. With this machine eight different lengths of cut can be obtained without buying or installing extra



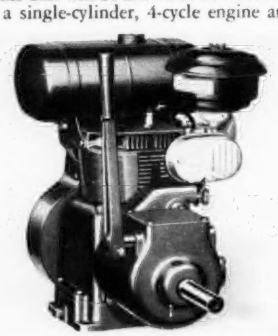
equipment—from 5/16 inch for silage to 3⅞ inches for field-cured hay. Both the windrow pickup and mower bar units have smooth, one-piece decks, which eliminate projections to snag hay or holes for leaves to fall through, and both feature overhead feeders which move light or heavy, cured or green crops positively, but reduce the possibility of stones being fed to the cutterhead.

Booklet on Diesel Tractor

Caterpillar Tractor Co., Peoria, Ill., will send on request to interested readers copies of its booklet (form 30379) on the Caterpillar diesel D6 tractor. The booklet, with photographs and model cutaways of the basic components of the tractor, describes what goes into making up each component.

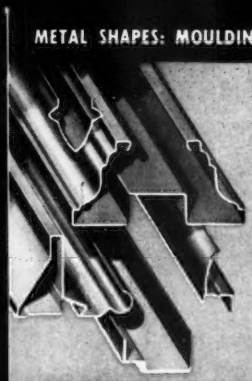
Air-Cooled 4-Cycle Engine

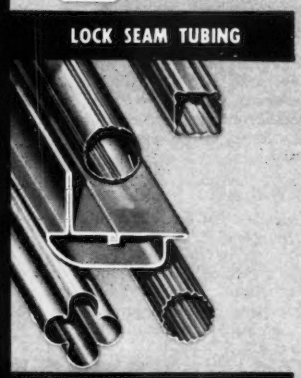
Kohler Co., Kohler, Wis., states that its recently announced K160 air-cooled engine is now available with a hand clutch, and that this unit will be known as Model K160C. It is a single-cylinder, 4-cycle engine and is



equipped with oil bath air cleaner, ball bearings, oil bath flyball governor, fuel filter, and silencer muffler. The fuel tank has a capacity of 1¼ gal. The power output of the unit varies from 3.7 to 6.6 hp in the range of speeds from 1800 to 3600 rpm.

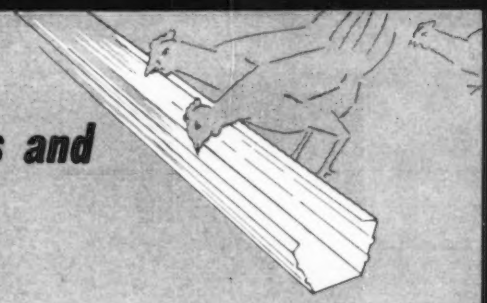
(Continued on page 184)

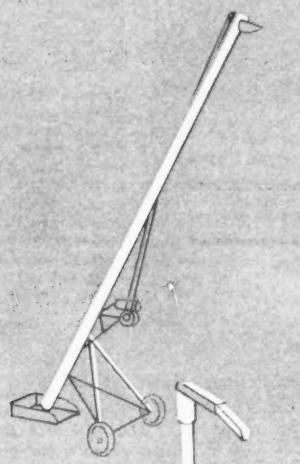


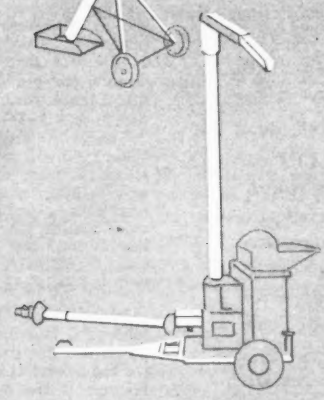


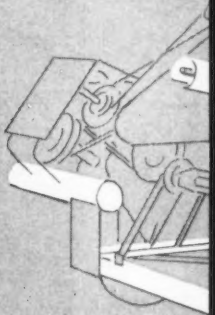
Van Huffel cold formed metal shapes and tubing simplify design and cut production costs for the makers of

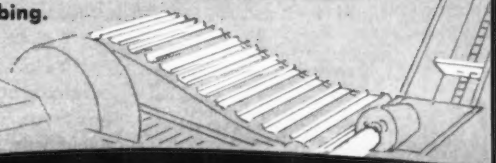
farm equipment

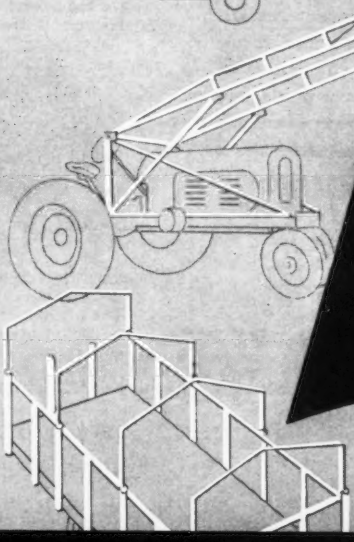












No matter what you make that farmers use, chances are Van Huffel Cold Formed Metal Shapes and Tubing can help you make it faster, cheaper and better.

Faster **because cold formed parts require very little or no machining; parts come to you shaped, cut, punched, or bent to your specifications.**

Cheaper **because of the high strength-to-weight ratio you can, in many cases, use lighter gauges, or smaller sizes in place of solid metals. Parts are uniform in thickness, free from scale, and ready to paint.**

Better **because of the wider latitude in choice of materials, design possibilities and fabrication methods. Shapes and tubing can be produced in Cold Rolled, Hot Rolled and High Tensile Steels. Van Huffel cold forms strip metals 1/2" to 33" wide; regular and irregular shapes in .018 to .312 gauge; tubing from 3/16" to 6" in diameter in any lengths.**

As competition brings demands for simplifying parts and lowering costs, we invite you to consult us on the possibility of doing the job better and more economically with Van Huffel metal shapes and tubing.

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Where ideas take shape for makers of farm equipment

The TERRALOAD'R, built by American Tractor Corp'n., Churubusco, Ind., features HYDRECO Oil Power which contributes to its great versatility, ease and speed of operation as Loader, Dozer and Excavator.

The famous Four-Bolt design HYDRECO Pump which locates the assembly bolts in the area of greatest internal pressure. 3 to 130 gpm for working pressures to 1500 psi at speeds to 2000 rpm.

Yes, the TERRALOAD'R is

Oil Powered by a

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No glass-house weakling is the TERRALOAD'R. Out where the going is rough ...moving stones, gravel, sand or dirt... day after day...rain or shine...There you find the TERRALOAD'R! And the source of its hydraulic power is a sturdy, dependable HYDRECO Four-Bolt Pump delivering 7 gpm at 1000 psi.

HYDRECO Hydraulic components are original equipment on more and more hard working vehicles in the construction, agricultural and earth moving fields, because they perform up to the expectations of design engineer and operator alike.

Write for complete information on HYDRECO Pumps, Motors, Valves, and Cylinders for your hydraulic circuits.

HYDRECO Gear Type Motors featuring the easily serviced Four-Bolt design . . . fully reversible . . . delivering up to 52 hp.

HYDRECO Hollow Plunger Valves with capacities of 5 to 80 gpm . . . 1 to 5 single or double acting plungers . . . covering virtually any application.

HYDRECO Single Acting, Double Acting, and Telescopic Cylinders as well as those of special design.

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THE NEW YORK AIR BRAKE COMPANY

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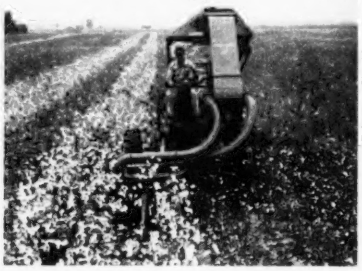
New Products and Catalogs

(Continued on page 182)

One-Row Cotton Picker

John Deere, Moline, Ill., announces the new John Deere No. 1 one-row cotton picker which mounts on John Deere Models 50, 60, and 70, and late A tractors. The tractor operates in reverse and cotton enters the picking unit without going under the tractor axle. The tractor supplies the power for propelling the outfit, operating the picking units, and driving the fans, and its hydraulic system raises and lowers the picking unit



and dumps the basket. The picking unit consists of a front and rear drum of spindle bars. Cotton plants pass between the two drums where they are picked from both sides. The spindles are spaced to allow green or partly open bolls to escape unharmed. Transport of the equipment is convenient; the remote gear-shift linkage is disconnected by removing one pin, and the operator steps from the operator's platform to the tractor seat for transporting at regular tractor forward speeds.

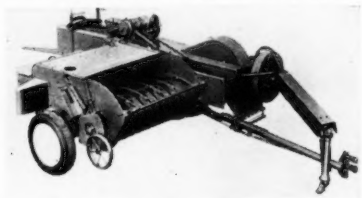
Farm Almanac

The Ford 1954 Almanac for Farm, Ranch and Home is a 208 page, 5¼ x 7½-inch booklet, illustrated in color, indexed, and filled with almanac-type brief treatment of a variety of subjects. It is edited by John Strohm, and published for the Ford Motor Co., Detroit, Mich., by Simon and Schuster. List price is $1.00 per copy.

This is the first Ford Almanac published since 1936. It recognizes that farm people today are more receptive than ever before to new information and ideas, and aims to make a great deal of new sound information more readily available for reference than has been the case in recent years.

Power Take-Off Baler

New Holland Machine Co., New Holland, Pa., announces its new Model 66 power-take-off baler designed particularly for family-size farms. One of its important features is the over-running clutch which makes baling from the power take-off prac-



tical. It is possible to shift gears up or down to meet changing windrow conditions. The machine is equipped with a slip clutch to protect baler and tractor under fast full-power starts and heavy loads. It has adjustable bale-length control and roll-away bale chute as standard equipment.

(Continued on page 186)

TAKE THEIR WORD FOR IT!

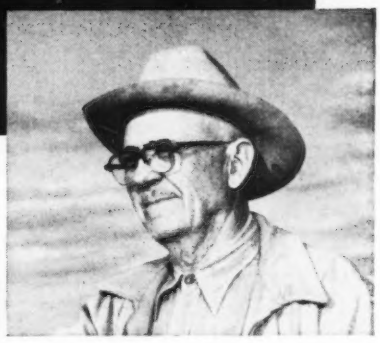
PRESSURE-CREOSOTED Fence Posts save money

Boyce Tiser, *Cleveland, Mississippi,* says:

"About 6 years ago we started replacing our old, untreated fence posts with Pressure-Creosoted Posts. I like the good-looking appearance of a fence made with Pressure-Creosoted Posts, and, of course, they are much easier to install and the fence wire goes on more easily. We've also used Pressure-Creosoted Lumber and Poles in pole barns, tractor sheds, and other buildings. There has been no sign of deterioration or decay."

J. C. Baber, *Manager of Alpine Farms, Natural Bridge Station, Virginia,* says:

"Until recently we have been using untreated locust and pine posts, which have proven most unsatisfactory in service and upkeep. Therefore, we are converting all our fencing to the use of Pressure-Creosoted Posts. We feel assured these posts will last us 40 to 50 years, which will result in considerable savings."



James S. Kreycik, *of Wood Lake, Nebraska,* says:

"Twenty-one years ago we purchased our first Pressure-Creosoted Fence Posts. We like them because they're long-lasting and highly fire-resistant, and they make a strong, straight, good-looking fence. We're replacing untreated posts with Pressure-Creosoted Posts at the rate of about 2000 a year; eventually we will have over 60 miles of boundary and cross fences using Pressure-Creosoted Posts."

THE men who are using them are the men best qualified to talk about the advantages of Pressure-Creosoted Fence Posts. And hundreds of farmers have told us they can build a longer-lasting, better-looking fence with Pressure-Creosoted Posts than with any other wood posts on the market today.

Pressure-Creosoting is a carefully-controlled, engineered operation where exactly the right amount of Creosote is forced deep into the wood to give the post maximum protection against the natural enemies of wood. And the posts used for Pressure-Creosoting are carefully selected for uniformity, straightness and ease of erection.

You can recommend Pressure-Creosoted Fence Posts without hesitation as the most economical wood posts that can be used. The small extra cost of Pressure-Creosoting is repaid time and again in extra life and savings in labor.

Many leading wood-treating plants use U·S·S Creosote in their wood treating operations. When fence posts—or any other type of farm lumber—are treated with U·S·S Creosote, you can be sure a quality product has been used.

• • •

UNITED STATES STEEL CORPORATION

525 William Penn Place • Pittsburgh 30, Pa.

Free guide to better fencing

If you would like more information on approved methods of fence construction with Pressure-Creosoted Posts, send for our guide "Fences That Pay." If, after examining it, you would like additional copies for your educational program, they will be supplied without charge. Use the coupon.

USS TRADE MARK

Agricultural Extension Section
United States Steel Corporation
Room 4260, 525 William Penn Place
Pittsburgh 30, Pa.

☐ Please send me your new guide, "Fences That Pay."

☐ Also, I would like to know the name of my nearest Pressure-Creosoted Fence Post Supplier. No obligation, of course.

Name .....

Address ..... Town .....

County ..... State .....

UNITED STATES STEEL

"Why do engineers recommend PRESSURE-CREOSOTED fence posts?"

● Why? Because controlled tests have proved that pressure-creosoted posts last 3 to 5 times longer than most types of untreated posts. That extra-long life reduces repair and replacement costs to a bare minimum, saving the farmer valuable time and money that he can apply to other projects on his farm.

Pressure-creosoting preserves fence posts in another way, too. Repeated grass fires that often damage untreated posts merely char the surface of pressure-creosoted posts, leaving them unharmed.

For complete details on creosote and its uses, write to Koppers Co., Inc., Tar Products Division, Pittsburgh 19, Pennsylvania.

KOPPERS COMPANY, INC., PITTSBURGH 19, PENNSYLVANIA

Tar Products Division

DISTRICT OFFICES:

Woodward, Alabama
122 S. Michigan Avenue, Chicago, Illinois
350 Fifth Avenue, New York, N. Y.
250 Stuart Street, Boston, Massachusetts
3450 Wilshire Blvd., Los Angeles 5, California
Koppers Building, Pittsburgh, Pennsylvania

All Standard Specifications

KOPPERS CREOSOTE

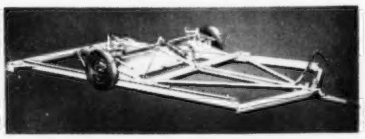
The Performance-Proved Wood Preservative

New Products and Catalogs

(Continued from page 184)

Hydraulic Controlled Land Leveler

The Eversman Mfg. Co., Denver, Colo., announces two new land levelers and dirt movers, known as Models 9H and 12H, which have full hydraulic control of the cutting blade from the tractor seat. Both models are shipped less hydraulic cylinder



and hoses and any standard ASAE double-acting cylinder can be used. On all Eversman models, for automatic leveling action, the wheels control blade movement through a patented crank axle. The company now makes six models of land levelers, all for use with regular farm tractors.

New Straight-Through Baler

New Idea Farm Equipment Co., Coldwater, Ohio, announces a new straight-through baler with large, free-floating pick-up and a continuous-tying mechanism which eliminates skip tripping and double tripping. It is available for twine or wire tie. It can be powered with a 23-hp engine or by the power take-off of a two-plow tractor. Under favorable conditions it has a capacity of 8 tons a day. Bale weight is easily reg-

ulated and the machine can be adjusted for 32, 38 and 44-in bales. The machine's mechanism is protected by two shear bolts in the flywheel and main-drive sprocket. Both the infeed and feed ram are equipped with overload releases and a throwout from the tractor seat allows the operator to stop the pick-up and auger while the feed ram continues operating to clear out an excessive load.

The bale chute can be raised or lowered as desired for loading on wagon or ground.

Farm Mechanization Milestones

Allis-Chalmers Mfg. Co., Tractor Division, Milwaukee, Wis., will send on request to interested readers a copy of a new publication entitled "Allis-Chalmers Milestones in Farm Mechanization," beginning with the first low-pressure rubber tires used on a farm tractor which were installed on an Allis-Chalmers tractor in 1932 and closing with this company's more recent developments in its tractor and implement lines.

(Continued on page 188)

LOW-COST MOTOR GRADER

handles unlimited jobs on a limited budget

How often have you seen earth-moving jobs that were too big to be handled efficiently with ordinary farm implements, yet did not warrant the cost of a large motor grader? Jobs like these are made to order for the Allis-Chalmers Model D Motor Grader.

Here is a real earth-moving machine — a *natural* for such jobs as building terraces, waterways, diversion ditches, shallow stock ponds and farm roads. The tandem drive Model D has all the essential design and performance advantages of large motor graders, yet it costs only ⅓ as much.

But its advantages go far beyond the cost sheet. For example, its compact design and short turning radius enable it to work close to fences, to travel easily through farm lanes and across farm bridges. What's more, any mechanic can service its 50-hp. gasoline engine. Parts are carried by all Allis-Chalmers tractor dealers.

Let your Allis-Chalmers industrial tractor dealer show you the Model D in action. See for yourself how nicely it fits the job . . . how easily it fits the budget.

Brake hp., 50
Weight, 8,800 lb.
Speeds, 4 forward to 25.6 mph.
Reverse, 3.3 mph.

OPTIONAL EQUIPMENT
Scarifier
Leaning Front Wheels
Power Circle Turn
Rear-Mounted, ⅜ cu. yd. Hydraulic Loader

ALLIS-CHALMERS
TRACTOR DIVISION • MILWAUKEE 1, U. S. A.

Power you can punish!

That's LE ROI heavy-duty power

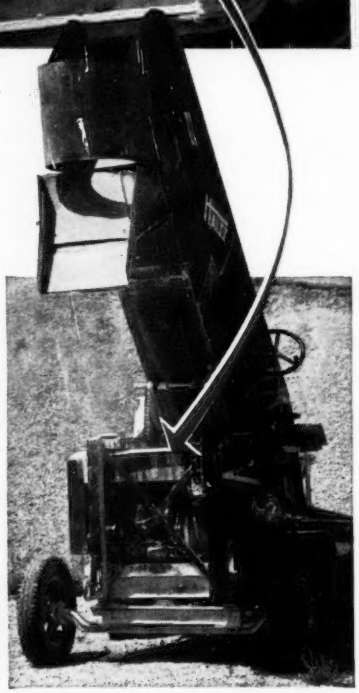
Power that pays off in
Dependable service!
Operating economy!
Easy maintenance!

THE extra reliability of Le Roi engines is a proved fact — proven by dependable and economical performance on one tough job after another.

A Le Roi is no automotive lightweight — it's a power-packed valve-in-head engine designed from scratch for *heavy-duty* service. It has the weight and stamina it takes to stand the punishment handed out to field equipment. It has advanced design, precision machining, and quick-maintenance features.

These are reasons why Le Roi is a leader in the heavy-duty field. They're reasons why you find so many Le Roi engines powering oilfield equipment, construction equipment, industrial machinery, and agricultural equipment.

Let Le Roi's performance record guide your judgment, when you buy equipment or select engines for original-equipment or replacement power. Le Roi has a full range of sizes from 15 to 635-hp — for gasoline, natural gas, butane. And remember — Le Roi power is power that pays off.



A typical Le Roi engine application in the construction field—powering a Haiss loader.

Write for latest bulletins.

LE ROI COMPANY
A Subsidiary of Westinghouse Air Brake Co.
MILWAUKEE 14, WISCONSIN
E-88

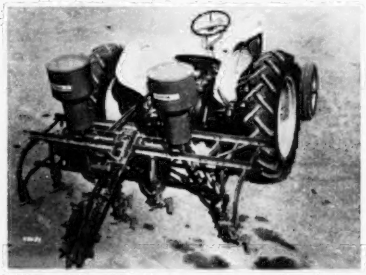
Plants: Milwaukee • Cleveland — Greenwich — Dunkirk, Ohio • Coldwater, Michigan

New Products and Catalogs

(Continued from page 186)

Fertilizer Side Dresser

Ford Motor Co., Tractor and Implement Division, Birmingham, Mich., announces a ground-driven side-dresser attachment for its Dearborn line of cultivators. The attachment has 17 flow-rate settings which allow applications of 50 to 500 lb of fertilizer per acre. Fertilizer hoppers, each with a capacity of



85 lb of dry fertilizer, can be removed conveniently for emptying or cleaning, and they are interchangeable with the hoppers on Dearborn corn planters.

Applicants for Membership

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Beckham, C. H.—Sales engineer, Esso Standard Oil Co. (Mail) 2420 Seneca Road, Westfield, N. J.

Bernard, J. L., Jr.—President, Communication Products Co., Inc., Marlboro, N. J.

Biehn, Marley M. — Agricultural engineer (SCS), USDA, San Fernando, Calif. (Mail) 15069 Nurmi St.

Bishop, Ralph E.—Soil conservationist (SCS), USDA, Box 647, Dixon, Calif.

Blaisdell, Fred W.—Project supervisor, St. Anthony Falls Hydraulic Laboratory, University of Minnesota, Minneapolis, Minn. (Mail) 4540 30th Ave. S.

Bluedorn, Carl A. — President and general manager, Zeidler Concrete Products Co., PO Box 2368, Waterloo, Iowa

Burtschi, William T.—State engineer (SCS), USDA, 2800 South Eastern, Oklahoma City, Okla.

Cole, Marvin D. — Agricultural sales engineer, The Ohio Power Co., 6th and Washington Sts., Portsmouth, Ohio

Collins, Charles A.—Engineer, South Mississippi Manufacturing and Engineering Co., Poplarville, Miss. (Mail) RR 3

Coulter, Joel B. — Owner, Coulter Farm Management, 1500 Edna St., Bakersfield, Calif.

Cranston, Maurice D. — Agricultural engineer (SCS), USDA. (Mail) c/o Soil Conservation Office, Highmore, S. D.

Cunningham, Floyd M.—2nd Lt., U.S. Army. (Mail) Student Officers Company, Ft. Belvoir, Va.

Free, George R. — Project supervisor (ARA), USDA. (Mail) 308 Hector St., Ithaca, N. Y.

Heysen, Luis E.—Agricultural engineer, Department of Agriculture and Commerce, PO Box 8458, Fernandez Juncos Station, Santurce, Puerto Rico

Kleinhenz, Arnold F. — Soil conservationist (SCS), USDA. (Mail) 212 South St., Wapakoneta, Ohio

(Continued on page 190)

dig this powerful ditcher

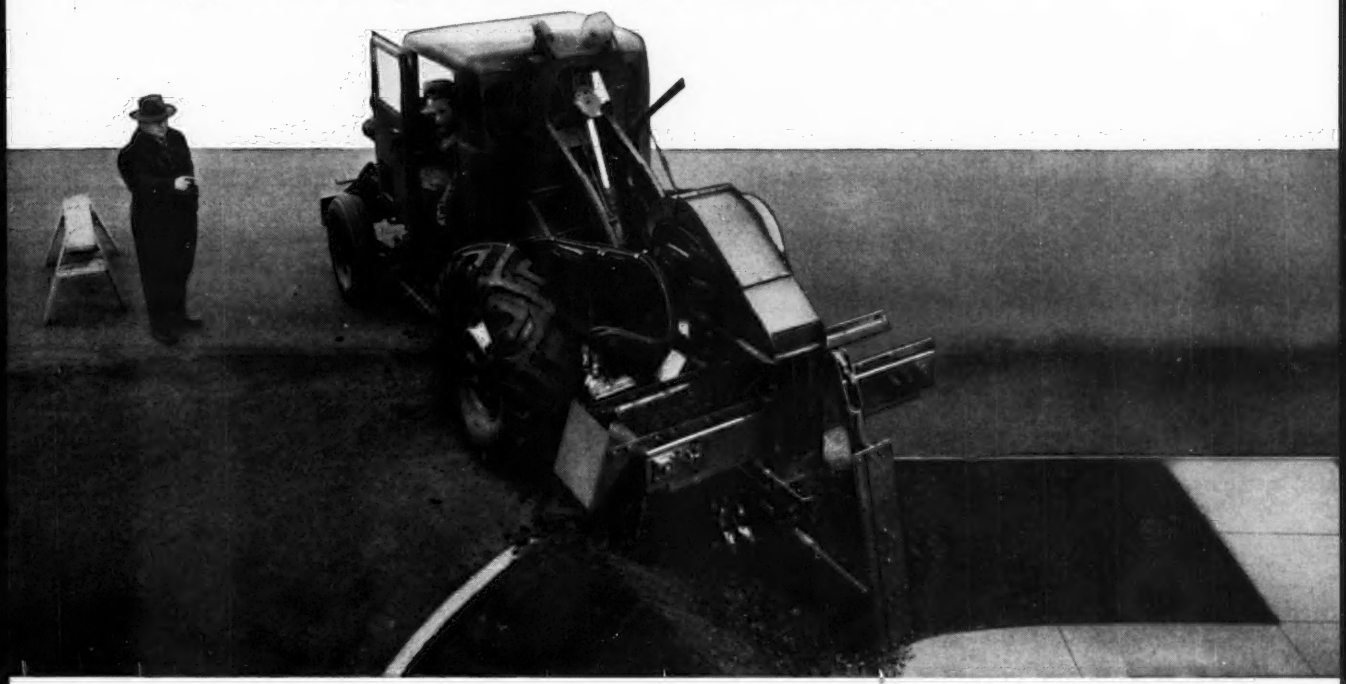


PHOTO COURTESY BARBER-GREENE COMPANY, AURORA, ILLINOIS

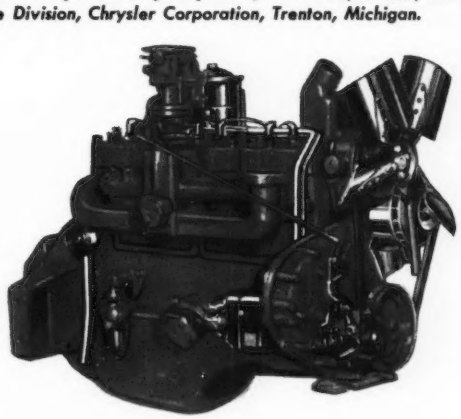
Chrysler *power and gýrol Fluid Coupling team up to put the "run" in runabout.*

When the operator of this ditcher "lowers the boom" things happen fast. That's because the vertical boom concentrates the weight of the unit on the work, bringing additional pressure to bear on digging buckets. This, in turn, allows them to bite into practically any kind of ground formation, frozen soil or even bituminous pavement. Upon completion of digging, a simply-operated hydraulic control raises the boom and the unit takes off—automotive style—down the highway to the next job.

Behind the power and dexterity of the Barber-Greene Runabout is the Model 8 Chrysler Industrial Engine and Chrysler gýrol Fluid Coupling. This 250 cubic inch displacement engine with its wide speed range drives the bucket line, crowds the ditcher along the trench, supplies power to the hydraulic boom hoist and takes the ditcher to the next job at traffic speeds. Chrysler gýrol Fluid Coupling helps the operator coordinate crowding and bucket line speeds for maximum digging efficiency.

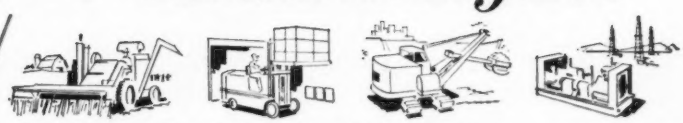
If your equipment requires power within our 217 to 413 cubic inch displacement range, engines that will operate equally well with gasoline, natural or L-P gas fuels, engines ideally suited to power take-off, then see a Chrysler Industrial Engine Dealer. He can supply *engines equipped at the factory for their jobs in the field.*

Remember too that Chrysler Power is not expensive. Production-line methods adapted to specialized industrial engine building provide a custom-built engine at mass-production prices. If you prefer, write: ***Dept. 163, Industrial Engine Division, Chrysler Corporation, Trenton, Michigan.***



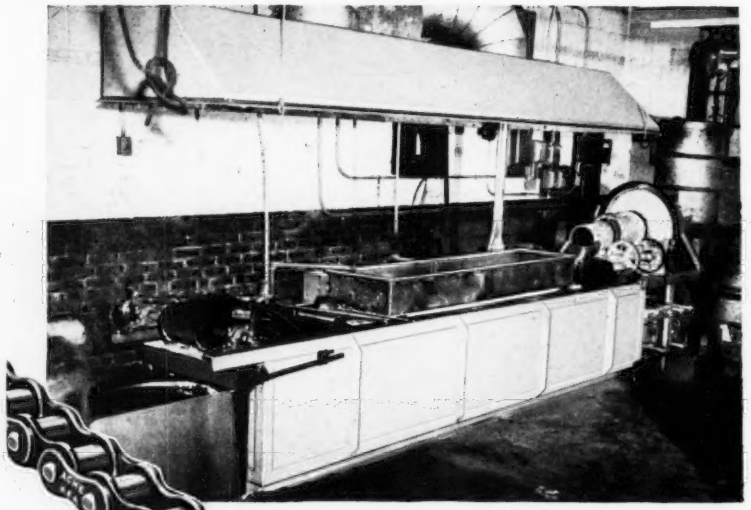
CHRYSLER *Industrial Engines*

HORSEPOWER WITH A PEDIGREE



AGRICULTURE • INDUSTRY • CONSTRUCTION • OIL FIELDS

No. 3 - Precision Operations in the Manufacture of ACME Chains



Special electric furnaces produce a distinctive chemically blued steel on side plates for better appearance and rust protection.

Service is the Keynote OF **ACME'S** SUCCESS

By SERVICE we mean shipments made the day order is received on practically all standard makes of ACME Chains.

On "Special Chain" orders, we aim to make deliveries one or two weeks sooner than you would normally expect. Large stocks and flexible manufacturing facilities make this possible.

Telephone in your next order and get acquainted with ACME lightning service.

Write *Dept. 9F for new illustrated 76 page catalog on use and application of roller chains and sprockets.*

Acme Chain Corporation
HOLYOKE
MASSACHUSETTS

Applicants for Membership

(Continued from page 188)

Krause, Merle G. — Farmer, RR 1, Scott City, Kans.

Miller, Richard A. — Agricultural engineer (SCS), USDA. (Mail) 625 Main St., Placerville, Calif.

Muir, Jack B. — Western editor, "Design News", 20 N. Wacker Drive, Chicago 6, Illinois

Newcomer, J. Leon—Graduate research assistant in agricultural engineering, Michigan State College, East Lansing, Mich.

Noteware, Warren D.—Owner, Delta Engineers, PO Box 1015, Rio Vista, Calif.

Pearson, James L.—Power use advisor, Big Bend Electric Co-op, Inc. (Mail) Box 342, Connell, Wash.

Pellett, A. W.—Tool engineer, New Holland Machine Co., New Holland, Pa.

Powers, Harold F. — Salesman, Polston Implement Co., 631 Western Ave., Seattle, Wash.

Rodriguez, Samuel del Valle—Soil conservation aid (SCS), USDA. (Mail) 84 Duliebre St., Mayaguez, Puerto Rico

Sandwick, Hazen A.—Agricultural engineer, U.S. Bureau of Reclamation, Ephrata, Wash. (Mail) Box 1148

Schroeder, Morris E.—U.S. Army. (Mail) RR 1, Milton, Pa.

Shustary, M. Jay—Assistant engineer, International Harvester Co., 2626 W. 31st Blvd., Chicago 8, Ill.

Smith, Giles E. — District sales engineer, Chain Belt Co., 4532 W. Greenfield Ave., Milwaukee 14, Wis.

Spiekerman, Fred N.—Owner, Ed Spiekerman Concrete Pipe Co., Lodi, Calif.

Stewart, Richard P. — Sales trainee, Caterpillar Tractor Co. (Mail) 803 Morris St., Washington, Ill.

Teerlink, James — President, Chains, Inc., 13943 Park Ave., Dolton, Ill.

Tolton, William W.—Assistant in sales promotion, Cockshutt Farm Equipment Ltd., Mohawk St., Brantford, Ont., Canada

Troxell, Robert J.—931 E. Grant Ave., Altoona, Pa.

Wakeman, Truman J. — Teacher-trainer in farm mechanics and associate professor of agricultural engineering, Virginia Polytechnic Institute, Blacksburg, Va.

Willardson, Lyman S.—Irrigation engineer, Agricultural Experiment Station, Lajas, Puerto Rico. (Mail) Box 34

Transfer of Membership Grade

Ameriks, Arturs R.—Assistant design engineer, J. I. Case Co., Rockford, Ill. (Mail) 730 N. Church St. (Associate Member to Member)

Berryhill, Gerald W.—Product design engineer, J. I. Case Co. (Mail) 3637 Orchard Ave., Davenport, Iowa. (Associate Member to Member)

Boyce, D. S. — Agricultural engineer in charge of work shop and pool, Department of Agriculture, F.E.S. Serdany, Sungi Besi, Selangur, Federation of Malaya. (Affiliate to Associate Member)

Clements, Lloyd W.—Agricultural engineer (SCS), USDA. (Mail) 17 Pendegast St., Woodland, Calif. (Associate Member to Member)

Levine, Gilbert—Assistant professor in agricultural engineering, Cornell University, Ithaca, N. Y. (Affiliate to Associate Member)

Rines, Bernard P.—Self-employed as agricultural engineer and contractor. (Mail) Walnut Crest Farm, Westbrook, Me. (Associate Member to Member)

Skinner, Thomas C.—Extension agricultural engineer, Agricultural Extension Service, University of Florida, Gainesville, Fla. (Associate Member to Member)

All the best **corn picker ideas** of three decades "rolled" into one **NEW IDEA**

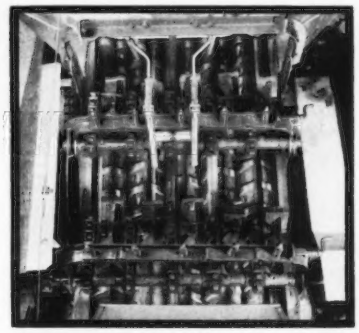
The New NEW IDEA Mounted Corn Picker

with large capacity 10-roll detachable husking unit

A corn grower likes the extra capacity and easy handling of the No. 20 Mounted Picker. After quick mounting, he finds he can do a better, cleaner picking job. He likes the way the No. 20 saves those few shelled kernels and keeps trash out of the wagon. He can do the entire job without leaving the tractor seat . . . controls for raising snapping unit, for adjusting snapping rolls, and elevator ear deflector are within easy reach. And when his crib is full of clean corn, the snapping unit and trailing husking bed are easily stored.

With out-of-the-way mounting brackets in place for the picking season, it's quick on and off . . . no hoists or garage equipment necessary. A new set of these inexpensive brackets is all that is necessary to change from one tractor to another.

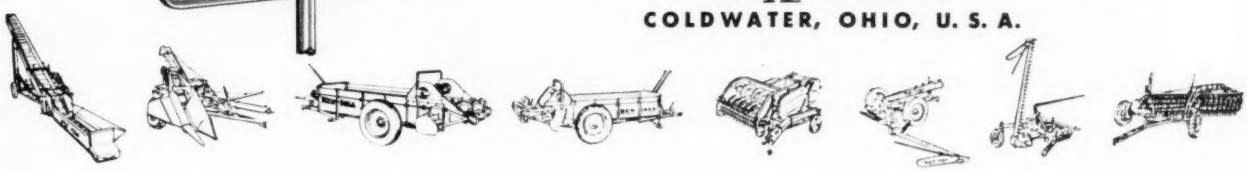
Distribution of the weight over six wheels takes the burden off the tractor . . . makes work possible in softer fields. Yes, we've really stepped into the future to bring the farmer this newest of NEW IDEAS . . . the NEW IDEA No. 20 Mounted Picker!



Extra large husking bed . . . for clean corn. Ten husking rolls, each 40" long, with ten individually operated presser wheels, do a clean job of husking. Caster wheels share the weight, make this over-size husking bed possible.

NEW IDEA FARM EQUIPMENT

NEW IDEA
FARM EQUIPMENT COMPANY
Division AVCO Distributing Corporation
COLDWATER, OHIO, U. S. A.



NEW BOOKS

FARM MECHANIZATION DIRECTORY, 1954. (Fourth Edition). Cloth, vii + 612 pages, 6 x 8¾ inches. Illustrated and indexed. Temple Press Ltd., Bowling Green Lane, London, E.C. 1. 21 shillings net. Parts and sections are as follows: Part I, organizations interested in farm mechanization, manufacturers' names and addresses, trade marks, names and abbreviations; Part II, tractors, power definitions of a tractor, index, agricultural tracklayers, wheeled tractors—over 10 hp, four-wheel, three-wheel, half-track conversions; wheeled tractors up to 10 hp, four-wheel, three-wheel, walking types and motor hoes, two-wheel, single-wheel; industrial and forestry, tracklayers, wheeled tractors; Part III, tractor test reports, index, tractor test reports: Part IV, implements (arranged alphabetically under classifications with abridged specifications); list of contents.

FBI REGISTER OF BRITISH MANUFACTURERS, 1954 (26th edition). Cloth, 952 pages, 7½ x 9½ inches. Federation of British Industries, 21 Tothill St., Westminster, London, S.W. 1, United Kingdom. Price not stated.

This directory includes a foreword by the president of the Federation, Sir Harry Pilkington, information on the Federation, brief comment on Britain's Industrial Progress since the War, FBI overseas services and representation, and product, advertisements, address, trade association, brand and trade name, trade mark, addenda, and index sections. Dividers between principal sections are visually indexed. The products of more than 6,600 firms are listed under more than 5,000 product and service headings covering the whole field of productive industry in Britain.

FARM ARC WELDING, by V. J. Morford. First edition. Cloth, xii + 456 pages, 6 x 8¾ inches. Illustrated. James F. Lincoln Arc Welding Foundation (Cleveland 17, Ohio) $2.00 in USA, $2.50 elsewhere.

Material submitted in Lincoln Arc Welding Award competitions is here combined with other experience to provide a new handbook for building, repairing and servicing farm equipment. The accuracy of plans and construction procedures has not been completely checked, but material included has been selected for apparent value. A detailed table of contents is provided in lieu of an index. Part I of the book covers general welding information, with sections on the place of the arc welder on the modern farm, using the farm welder, planning and equipping the farm shop, and suggested procedure in welding and cutting. Part II on repair, alteration and construction of farm equipment has sections on repairing farm equipment, hardsurfacing farm tools, post-hole diggers, manure loaders and spreaders, snow and earth moving equipment, tillage and fertilizer handling equipment, mowing and forage handling equipment, planting, seeding and seed processing equipment, harvesting and crop processing equipment, disease and pest control equipment, elevators, loaders and conveyors, farm wagons, trailers, trucks and machinery transports, carts and wheelbarrows, livestock and dairy equipment, poultry equipment, power saws, construction and adaptation of power units, hitches, lifts and hoists, fences and gates, farm buildings, farmstead equipment and improvements, household equipment, tools and service equipment, recreational equipment, specialized equipment.

Part III, on useful information, includes 8 tables of data on metal sizes, weights, properties, threads, etc.

VEGETATION AND WATERSHED MANAGEMENT by E. A. Colman. Cloth, xv + 412 pages 6 x 9 inches. Illustrated and indexed. Ronald Press Co., (15 East 26th St., New York 10, N.Y.) $7.00. This reference is subtitled "An Appraisal of Vegetation Management in Relation to Water Supply, Flood Control, and Soil Erosion." A foreword by Fairfield Osborne, president, the Conservation Foundation, which sponsors the book, hails it as a comprehensive summary of present information on the subject. Parts and chapters are as follows: Part I, introduction, water yield in the United States, problems of water-yield control; Part II, the watershed and the reservoir, control by structural works, vegetation and hydrological processes, control by vegetation, vegetation and structural works; Part III, vegetation regions of the United States, introduction to research, alternative kinds of vegetation, croplands, fire, grazed lands, tree-covered lands, the opportunities and the challenge.

SOIL SCIENCE SIMPLIFIED, by Helmut Kohnke. Published by the author, Helmut Kohnke (208 Forest Hill Drive, West Lafayette, Ind.) $1.00 postpaid. Here is a bulletin-size condensed text of 66 pages, planned to present basic concepts of soils without related technical detail, for laymen, beginners, short-course students, farmers, fertilizer salesmen, etc. It has chapters on the nature and function of soil, physical properties of soils, soil and water, chemical properties of soils, plant growth and plant nutrition, organic matter and microbes of the soil, soil classification, soil erosion, soil and crop management, soil conservation.

KOHLER ENGINES

4-CYCLE
AIR-COOLED

K160

K90 3.6 H.P.
K160 6.6 H.P.
K330 12.0 H.P.
K660 26.8 H.P.

Kohler Engines are engineered and manufactured to the high standards which have made the Kohler mark known for quality the world over.

Power for garden tractors, pumps, sprayers, snow removal equipment, grain elevators, hoists, portable saws, concrete mixers, compressors, industrial lift trucks.

Write for information

K330

Kohler Co., Kohler, Wisconsin
Established 1873

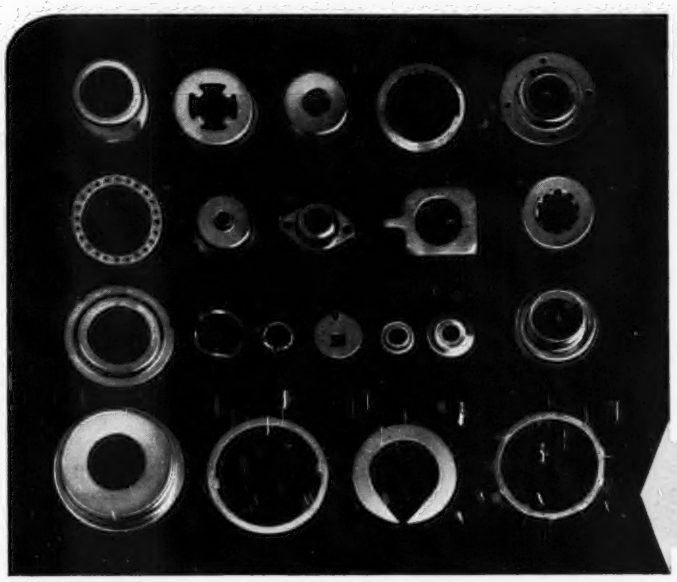
KOHLER OF KOHLER

PLUMBING FIXTURES • HEATING EQUIPMENT • ELECTRIC PLANTS
AIR-COOLED ENGINES • PRECISION CONTROLS

A Source You Can Rely on...
A Name to Remember

Experience is a valuable asset in the development, manufacture and distribution of any product. In this respect we offer you the cumulative benefits of *Continuous Service to Industry Since 1887* . . . including origination and pioneering of mass-production equipment for the economical manufacture of washers.

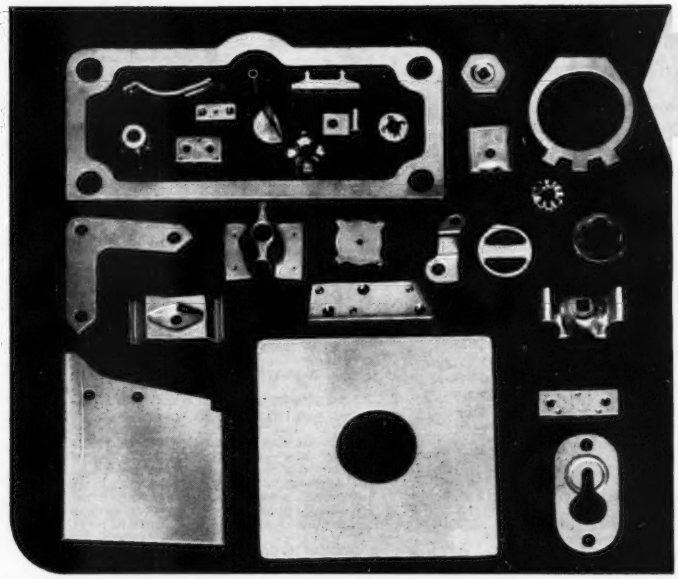
SINCE 1887



No matter what your washer requirements may be . . . whether for U. S. Standard Washers, SAE Washers, Rivet Washers, Lock Washers, Light Steel Washers, Finishing Washers, Machine Bushing Washers or Special Washers of any size, any desired material or finish . . . "MILWAUKEE WROT WASHERS" is the name to remember! Here, in the world's largest plant devoted to this specialized type of production, we have available more than 25,000 sets of dies — a priceless asset in providing the most complete and comprehensive selectivity to meet your needs.

Write for Catalog "30".

WASHERS



STAMPINGS

If it can be punched out of metal—if die-making ingenuity and tool-making facilities can provide the means for producing stampings to meet your production specifications; if the job can be handled most advantageously as a stamping—again, "MILWAUKEE WROT" is the name to remember. Here is a soundly established source of supply you can rely on — plus *Quality Standards* that are a source of pride to us, as manufacturers, and a source of satisfaction to our most discriminating customers. We'd like to serve you.

Let us quote on your requirements . . . covering fabrication in any material and in any finish. Furnished machined, heat-treated or surface-ground, as may be specified.

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THE WORLD'S LARGEST PRODUCER OF WASHERS

2210 SOUTH BAY STREET • MILWAUKEE 7, WISCONSIN

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PERSONNEL SERVICE BULLETIN

NOTE: In this bulletin the following listings still current and previously reported are not repeated in detail; for further information see the issue of AGRICULTURAL ENGINEERING indicated.

POSITIONS OPEN — 1953 — OCTOBER—O-348-534, 344-536, 361-537. NOVEMBER—O-341-538, 384-540. DECEMBER — O-430-542, 454-544, 465-545, 471-546, 479-547, 462-548. 1954—JANUARY—O-488-549, 491-550, 494-551, 508-552. FEBRUARY—O-13-601, 19-602.

POSITIONS WANTED — 1953 — SEPTEMBER—W-306-53, 339-56. OCTOBER—W-357-58. NOVEMBER — W-356-62, 368-63, 367-64, 388-65, 369-66, 381-69, 398-72, 404-74, 426-75. DECEMBER—W-395-76, 410-77, 431-78, 396-79, 405-80, 425-81, 420-82, 443-83, 423-84, 453-85, 451-87. 1954 — JANUARY — W-456-88, 487-89, 490-90, 484-91. FEBRUARY—W-5-102, 20-103, 6-104, 24-105, 25-106, 45-107, 46-108.

NEW POSITIONS OPEN

AGRICULTURAL EQUIPMENT product planning manager. Responsible for all product planning work on current and forward model tractors, implements and accessories. Position requires establishment of design cost and profit planning product budgets. Will require analyses of design cost comparisons and competitive product studies. Determine feasibility of all quality improvement, cost performance or styling running changes in current models. Farm background preferred. Agricultural or mechanical engineering degree essential. At least seven years experience in the farm equipment industry on staff level engineering or product planning work. Must be able to write concisely and clearly and make presentations. Permanent position. Detroit area. Excellent opportunity. Minimum starting salary $9,000, plus benefits. O-65-603

AGRICULTURAL EQUIPMENT product planning engineer, for product planning of current and forward model tractors, implements and accessories. Responsible for analyzing design cost comparisons and competitive product studies. Farm background preferred. Agricultural or mechanical engineering degree essential. At least three years experience in farm equipment industry on general engineering work or product planning studies. Permanent position. Detroit area. Excellent opportunity for advancement. Minimum starting salary $5,000 plus benefits. O-66-604

AGRICULTURAL EQUIPMENT product planning engineer, for production programming and scheduling of current and forward model tractors, implements and accessories. Responsible for establishing sound production programs. Manufacturing background essential plus experience in production scheduling. Mechanical engineering college degree with some graduate business school training. At least three years experience in manufacturing scheduling and control work on a staff level planning basis. Permanent position. Detroit area. Excellent opportunity for advancement. Minimum starting salary $5,000 plus benefits. O-67-605

AGRICULTURAL ENGINEERS (2) for project engineering work on haying, harvesting, cultivating and planting equipment, with manufacturer in the Midwest. Age 25-40. Technical agricultural or mechanical engineering degree or equivalent. Five or more years experience in actual design of mounted cultivators and planters, or haying and harvesting machinery. Supervision experience desirable. Excellent opportunity with growing manufacturer having a long-term development program. Salary open. O-68-606

AGRICULTURAL ENGINEER for design, development and research work for large garden tractor manufacturer. Location in Wisconsin. No age limit specified. Man selected for this position will be placed in charge of engineering department and will have responsibility for development of new tractors and implements as well as improvement on existing models. Previous garden tractor experience desirable, but not an absolute essential. Excellent salary for the right man. O-73-607

AGRICULTURAL ENGINEERS for design, test, and research work in excellent engineering department of midwest hay and forage harvester manufacturing plant. Age 21-35. Graduate agricultural or mechanical engineer. Farm background and design, test or research experience desirable but not required. Desire to improve farm machinery, plus ability to work well with others. Excellent opportunities for advancement. Salary open. O-62-608

JUNIOR PRODUCT ENGINEER for development, improvement, field testing and preparation for production of farm machinery, including forage harvesters and other feed handling and processing equipment. Location, New York State. Age 22-30. Degree in agricultural or mechanical engineering, or both. Livestock farm background, familiarity with use of machinery and previous employment in farm equipment engineering desirable. Intelligence, good health, and ability to work with factory, office, and farm personnel. Good opportunity for advancement to chief product engineer. Reliable, long-established company in rural area. Salary $4800-5200 plus share in profits and other benefits. O-74-609

DESIGNERS (4) for design and development of heavy tractor equipment, including work on new products as well as redesign and improvement of present machines, and design for production. Midwest. Age 30-50. Graduate engineer or equivalent. About 10 years engineering experience, including 5 in actual design work. Prefer experience in heavy, tractor, or agricultural machinery. Able to work effectively with others. Excellent opportunity for advancement in growing company and department. Salary open. O-75-610

LAYOUT DRAFTSMEN (5) for work on new design and refinement of present design. Review work of detailers and draftsmen. Occasional work with manufacturing, tool design, and research. Midwest. Age 25-45. Engineering degree or equivalent. Advanced drafting experience, preferably in heavy, tractor, or agricultural equipment. Able to work effectively with others. Excellent opportunity in growing company and department. Salary open. O-75-611

EXPERIMENTAL ENGINEERS (2) for testing and development work on experimental tractor equipment. Some advanced drafting, shop activity, and possibly occasional travel. Midwest. Age 25-45. Engineering graduate or equivalent. Engineering experience, preferably in heavy, tractor, or agricultural equipment. High mechanical comprehension. Some design and development experience. Able to work effectively with others. Excellent opportunity in growing company and department. Salary open. O-75-612

(Continued on page 198)

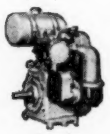
This Unit Chops Up Bales "Beds Down" Strawberry Plants

It's WISCONSIN-Powered

Many field hands once were needed to cover strawberry plants in a single field. Now, two men with a machine, built by Friday Tractor Co., Hartford, Michigan, handle the entire operation — chopping up baled straw, then spreading it evenly over the beds. Trailer-type unit is powered by a Wisconsin Heavy-Duty Air-Cooled Engine.

Wherever you need dependable power confined to the smallest space, your best choice is a Wisconsin Engine in the 3 to 36 hp. range. The feature of thrust-absorbing tapered roller bearings at both ends of the crankshaft practically eliminates bearing failure. Service-free, fool-proof AIR-COOLING at all seasons is another time- and maintenance-saving feature. So are an *easily-serviced* outside magneto with impulse coupling for fastest starts, plus heavy-duty construction for rugged farm service.

Complete your power files with the new 64-page Wisconsin Engine catalog, giving detailed specifications on all 4-cycle single-cylinder, 2-cylinder and V-type 4-cylinder models, 3 to 36 hp. — *plus* many application pictures.


4-cycle single-cylinder, 3 to 9 hp. models.

2-cylinder 7 to 15 hp. models.

V-type 4-cylinder 15 to 36 hp. models.

MOST H.P. HOURS

WISCONSIN MOTOR CORPORATION

World's Largest Builders of Heavy-Duty Air-Cooled Engines

MILWAUKEE 46, WISCONSIN

A-7672-½-I

Electronic Magic

...working to improve farming's future!

Farm implements "write" their own success stories electronically in a new technique used by Ford Tractor research engineers to design better tools for better farming.

A mobile stress and strain laboratory, called the "Travelab," field tests the Ford Tractor and Dearborn Equipment in varying soil conditions across the country. Equipped with the most advanced electronic instruments, it measures and records the stresses and strains in implements at work. By interpreting electronically-written graphs, engineers have positive facts to use in checking farm implement design.

The "Travelab" can be used with any type of farm equipment—from plows and cultivators, to cotton harvesters and hay balers. And it can test this equipment almost anywhere—in Georgia clay, Iowa loam, or Texas sand.

This new mobile laboratory is just one phase of an intensive agricultural research program being carried on by Ford engineers to provide the equipment farmers will need in the years to come . . . equipment that will further ease the farmer's burdens and increase his profits.

INSIDE THE "TRAVELAB"

A Ford research engineer watches as stress and strain pulses are flashed electronically to oscillographs, that record the whole story on graph paper. The mobile laboratory is a self-sufficient unit, equipped with a telephone system for communication among test members, and ultra-high speed motion picture equipment.

TRACTOR AND IMPLEMENT DIVISION
FORD MOTOR COMPANY
Birmingham, Michigan

Ford TRACTOR

Ford Farming MEANS BETTER WORK... MORE INCOME PER ACRE

For Positive Power Transmission on your Farm Equipment

specify

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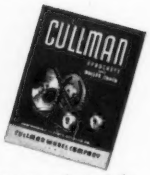
ROLLER CHAIN DRIVES

EFFICIENT
ECONOMICAL
DEPENDABLE

- **No slip or stretch**
- **Exact speed ratios maintained**
- **Maximum delivered horse power to driven unit**

If you too want roller chains that can take it—that can cut operating costs and give top performance, then take advantage of a Cullman roller chain drive tailored to your needs.

For full information or help on your power transmission problems write direct or contact the Cullman man in your area.



See our insert in Sweet's Catalog for Product Designers, or for complete data write for catalog No.51, shown above

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POWER TRANSMISSION
ROLLER CHAINS AND SPROCKETS

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Accept No Substitute!

Insist on Original, Patented

McDowell

IRRIGATION
COUPLINGS

The First and Finest Patented Gasket-Coil Pressure Lock Design

In this unique design, water pressure provides a watertight seal automatically—at both high or low pressures. No tools required. No hooks, latches or gadgets. Faster and easier to use, the McDowell Coupling saves time and money.

For Details, **MAIL COUPON TODAY!**

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the BADGE of him who BELONGS

DESPITE the *presumption* it sets up, mere membership in the American Society of Agricultural Engineers is no *proof* of a man's high rank in technical talent. It does prove that he has met certain minimum requirements and has earned the esteem of colleagues who sponsored his application for membership.

But the Society emblem is *evidence* that native talent, be it great or small, is enriched by fraternity with the personalities whose minds fuse to form the pattern of progress in the methods and mechanics of agriculture. The wearer of the emblem waits not for the debut of an idea, but is present at its birth and helps to guide its growth.

Be you novice or veteran, your membership in the organized profession adds something to your efficiency, your vision, your influence as an individual engineer. The Society symbol on your lapel is token that you "belong". Wear it.

STYLES AND PRICES OF ASAE EMBLEMS

With blue ground for Fellows, Members, and Associate Members — furnished either in pin with safety clasp or lapel button — $3.50 each.

With red ground for Affiliates — furnished only in pin with safety clasp — $3.50 each.

Send orders to ASAE, St. Joseph, Michigan.

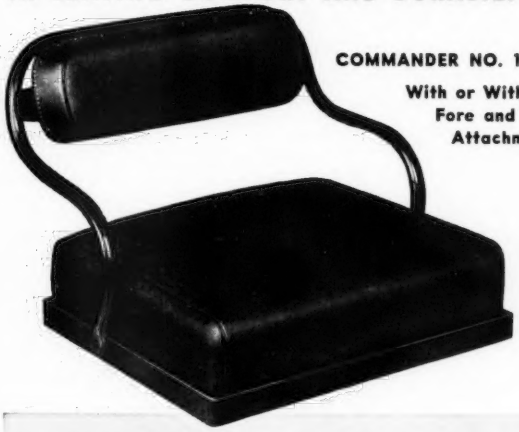
For ROUGH TOUGH HARD going

Milsco MILWAUKEE

SENIOR CONTOUR NO. 1893

Cushion Seats

MILSCO BRINGS YOU NEWEST ADVANTAGES IN SEATING COMFORT AND DURABILITY



COMMANDER NO. 1144

With or Without Fore and Aft Attachment

Improved driver-comfort is one of today's major engineering objectives . . . and Milsco can help you to step up the man-work-factor of your equipment with job-fitted cushion seating. Milsco Cushion Seats are the developments of years of experience in designing and manufacturing heavy duty cushion seats for all types of mobile equipment. Our field studies of enduring cushioning materials and contour body support may prove of important value to you. Write us about your seating problem now.

Sold Only to Original Equipment Manufacturers

ESTABLISHED 1924

Milsco MILWAUKEE

MILSCO MANUFACTURING CO.
2732 N. 33rd ST., MILWAUKEE 45, WIS.

DEPENDABLE PERFORMANCE calls for STOW

Picture courtesy BROOME G. L. F. ELEVATOR

G.L.F. depends on STOW flexible shafting for speedy grain delivery!

"Since installing STOW flexible shafting on our bulk feed delivery units, we have lost no time due to breakdowns and have had no maintenance problems in over five months of continuous service", says Mr. Joseph Collins, manager, Broome G.L.F. Elevator.

This STOW flexible shaft application replaces a universal joint series which would not stand up under the rugged conditions to which it was subject during deliveries to farms. Primary cause of the failure, according to Mr. Collins, was the steep angles through which the universal joints had to operate. Prior to the installation of STOW flexible shafting, Broome G.L.F.'s grain delivery units suffered frequent breakdowns, each of which involved three or four-hour delays and upped delivery costs.

This is another excellent example proving the efficiency, the practicability of STOW flexible shafting. Why not consult with STOW engineers on *your* next power transmission problem?

WRITE TODAY for your FREE Torque Calculator and Bulletin 525 containing complete data on STOW flexible shafting. No obligation, of course.

STOW

first in flexible shafting since 1885

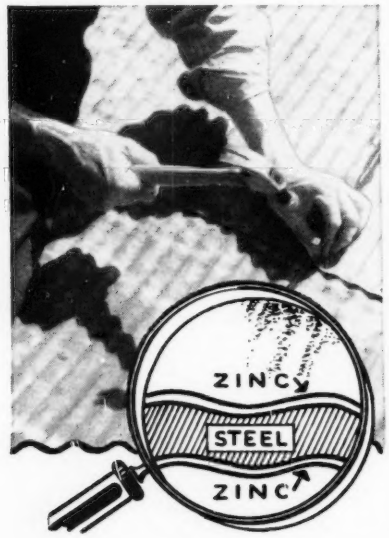
39 SHEAR STREET
BINGHAMTON, NEW YORK

MORE FOR YOUR MONEY

with

Grade-Marked

GALVANIZED ROOFING



Value in galvanized roofing is measured in rust-free service—and rust-free service depends on the weight or thickness of the zinc coating.

This weight or thickness of zinc coating cannot be determined by looking at a galvanized sheet.

Insist on *grade-marked* galvanized roofing and know what you are getting. A small difference in the weight of coating means a large difference in the length of service.

It is thrifty to purchase metal roofing that is *grade-marked* to show the weight of the zinc coating.

Select the proper grade for the proper use—and for long rust-free service life and lowest per-year cost . . .

Specify a heavy-coated sheet such as "Seal of Quality," the SUPER SHEET for SUPER SERVICE

ZINC INSTITUTE 2 oz. COATING SEAL OF QUALITY

FREE . . . INSTRUCTION MANUALS

WRITE: AMERICAN ZINC INSTITUTE
324 Ferry Street, Rm. 202
Lafayette, Indiana

- ☐ Facts about Galvanized Sheets
- ☐ Directions for Laying Galvanized Sheets
- ☐ Metallic Zinc Paint Protects Metal Surfaces

Name_____

Address_____

City_____

Personnel Service Bulletin

(Continued from page 194)

NEW POSITIONS WANTED

AGRICULTURAL ENGINEER for teaching and research in farm structures with college anywhere in U.S.A. Married. Age 35. No disability. BS deg in education, 1948. BS deg in vocational education, 1953. MS deg in agricultural engineering, 1954. High school vo-ag teacher 2 yr. Teaching assistantship in agricultural engineering 1 yr. College instructor, temporary appointment 1½ yr. War enlisted and commissioned service 4½ yr, including 2 yr in European Theater. Available July 1. Salary open. W-16-110

DESIGN, DEVELOPMENT, or research in power and machinery with manufacturer, processor, distributor or federal agency, anywhere in U.S.A. Married. Age 26. No disability. BS deg in agriculture with emphasis on agricultural engineering Oregon State College, 1952. Dairy farm background. Summer work during college years on logging crew and driving logging truck. With farm equipment dealer since graduation as assistant accountant, and currently, parts manager. Enlisted service in Navy nearly 3 yr, machinist mate second. Available on 3 weeks notice. Salary $4800. W-43-111

AGRICULTURAL ENGINEER for extension, teaching, or research in power and machinery or soil and water field, with college or experiment station in U.S.A. or Canada. Married. Age 35. No disability. BS deg in agriculture, 1946, University of Alberta. BS and MS deg in agricultural engineering 1947 and 48, University of Saskatchewan. Work during college years, two seasons of 6 mo each assisting in experimental work on field crops. Tractor operator 6 mo in connection with Masters Thesis on "Land Clearing and Reclamation." Work with experimental substations 6 mo as illustration supervisor, 6 mo as settlement supervisor. Farm service engineer in agricultural extension, technical service, and sales promotion with oil company, 5½ yr. War service RCAF as radar technician, over 3 yr. Available on reasonable notice. Salary open. W-56-112

AGRICULTURAL ENGINEER for design, development, or research in power and machinery, rural electric, or product processing field with manufacturer, processor or farming operation, anywhere in U.S.A., preferably West. Married. Age 25. Corrected vision. BS deg in agricultural engineering 1951, MS deg in agricultural engineering with emphasis in electrical and mechanical engineering, 1953, both at Washington State College. Experience with college agricultural engineering department in work on bean drying and on chick brooding. Summer work with Soil Conservation Service. Since graduation, power use advisor with REA Co-op, extension and public relations work. Available in June or July. Salary $4800. W-54-113

AGRICULTURAL ENGINEER for applied research, design and development of farm machinery, trouble shooting and servicing on new products, or supervision of maintenance and operation of farm machinery, with industry, anywhere in U.S.A., or certain other countries. Willing to travel. Enjoy meeting people but not interested in purely sales work. Single. Age 30. No disability. BS deg in agriculture and in agricultural engineering, 1950, University of Missouri. Research engineer with manufacturer of grain drying and storage equipment 3 yr., on customer surveys, investigation and testing on grain drying system, investigation of customer complaints, cooperation with a state college on a tobacco curing project. War and postwar enlisted and commissioned service in Infantry. Available now. Salary $5000. W-29-114

AGRICULTURAL ENGINEER for design, development, sales, or service in irrigation or power and machinery with manufacturer or distributor, anywhere in U.S.A. Married. Age 27. No disability. BS deg in agricultural engineering, 1950, University of Minnesota. Sales engineer 3 yr with water supply equipment distributor, engaged in design, sales and service of filter plants, pumps, and portable irrigation systems. Machinist 4 mo. Sales two summers with national seed processing company. Midwestern farm background. War service in U.S.-N.R. 14 mo as aviation electronics technician's mate trainee. Available on reasonable notice. Salary open. W-70-115

AGRICULTURAL ENGINEER for design, extension, teaching, or research in farm structures or rural electric field with industry or public service in New England or Southeast. Married. Age 25. Corrected vision. BS deg in agricultural engineering, North Carolina State College. Part time college work in design and drafting for Extension Service. Private industry 6 mo, design and structural service. Active duty, U.S. Army, 21 mo civil engineer assistant in design and construction supervision on structures and utilities. Available July 1. Salary open. W-37-116

Minnesota Welcomes You

To the 1954 ASAE Annual Meeting, June 20-23, University of Minnesota, Minneapolis

AGRICULTURAL ENGINEER interested in field work, management, public relations or sales. Prefer work with agricultural production or processing problems that are related to farm power and machinery. Married. Age 31. No disability. BS deg in agricultural engineering expected in June, University of Arkansas. Business administration courses in high school. Service in U.S. Air Force as a flight engineer, 3 yr. Experience in aircraft and farm equipment industry, 3 yr. Farm background with two years farm experience after service. Available June 15. Salary open. W-64-117

AGRICULTURAL ENGINEER for design, development, extension, or teaching in farm structures or rural electric field, with industry or public service. Any location, Northeast preferred. Some travel if necessary. Married. Age 23. Corrected vision. BS deg in agricultural engineering, 1952, University of Massachusetts. MS deg in agricultural engineering expected in May, Purdue University. Junior agricultural engineer with consulting service while undergraduate. Research junior assistant, instructor rank, since June, 1952, while graduate student. Available June 1. Salary open. W-38-118

NEW BULLETINS

Electric Water Systems for Farms, by Jesse B. Brooks. Kentucky (Lexington) Agricultural Extension Circular 452 (revised May 1953).

This gives up-to-date information on water system elements and their characteristics, helpful in selection and installation to fit the water supply situation and water use requirements.

Minerals for Livestock. Kentucky Agricultural Extension (Lexington) Circular 360 (revised May 1953). Up-to-date information on feeding minerals and mineral supplements, including recommended feeding methods and equipment.

Fruit and Vegetable Processing Kitchen for Southern Locker Plants, by W. M. Bruce, W. E. Garner, and H. D. White. Bulletin 4, (July, 1953) Georgia Agricultural Experiment Station (Athens). Reports on a study made under the Research and Marketing Act of 1946, with the cooperation of the USDA. It covers processing kitchen layout, individual items of equipment, plant operation, operating cost analysis and recommendations.

Fan Ventilation of Poultry Houses, by Joseph A. McCurdy and Harry A. Kauffman. Pennsylvania Agricultural Extension Service (State College) Special Circular 13 (December 1953). The authors here reduce the technicalities of the subject to simple terms for practical poultrymen, and cover them under headings including benefits of poultry house ventilation, essential features of an automatic poultry house ventilation system, the moisture problem, building requirements, design of the ventilation system, and additional management practices.

"National security is impossible without financial security of individual citizens..."

FRED MAYTAG
The Maytag Company

"Ingenious research and the ability to produce . . . which have helped to make the United States the world's greatest nation . . . could not have been realized without the savings of millions of thrifty persons. Savings of individuals financed new inventions, developed others. The Payroll Savings Plan for purchasing Savings Bonds regularly provides an easier way for American workers to save for future spending or investment, for their own security, and for their nation's security. Our experience at the Maytag Company has shown us that a successful Payroll Savings program can be the foundation and the cornerstone of happy employee relations."

Let's point up Mr. Maytag's concise summary of the Payroll Savings Plan with a few very recent figures:

• at the close of February, 1953, the *cash value* of Series E Bonds held by *individuals* reached a new high: $35.5 billion. This is $1 billion more than the value of the Bonds held on May 1, 1951, when E Bonds began to mature.

• to this encouraging reservoir of future purchasing power, 8,000,000 Payroll Savers are adding $160,000,000 per month by their consistent investment in U.S. Savings Bonds.

• unit sales of E Bonds in 1952 reached the highest level of the past six years—more than 77 million individual pieces. Of the 77 million units, 67 million were in the $25 and $50 denominations—the bonds bought chiefly by Payroll Savers.

• Payroll Savers are serious savers—of the approximately $6 billion Series E Bonds which had become due up to the end of March, $4.5 billion, or 75%, were retained by their owners beyond maturity.

If you are not among the 45,000 companies that make the benefits of the Payroll Savings Plan available to their employees . . . or if you do have a Plan and your employee participation is less than 50%, a telegram or letter to Savings Bond Division, U.S. Treasury Department, Washington Building, Washington, D. C., will bring you all the information and assistance needed to build a *good* Payroll Savings Plan.

The United States Government does not pay for this advertisement. It is donated by this publication in cooperation with the Advertising Council and the Magazine Publishers of America.

AGRICULTURAL ENGINEERING

Index to Advertisers

Acme Chain Corp	190
Allis-Chalmers Mfg. Co.	187
American Zinc Institute	198
Bearings Co. of America	135
Blood Brothers Machine Co.	129
J. I. Case Co.	2nd cover
Caterpillar Tractor Co.	134
Chrysler Corp.	189
Cullman Wheel Co.	196
Dayton Rubber Co.	138, 139
Deere & Co.	146
Fafnir Bearing Co.	132
Ford Tractor Div., Ford Motor Co.	195
Great Lakes Steel Corp., Stran-Steel Div.	142, 143
Hydreco Div., The New York Air Brake Co.	184
Hyatt Bearings Div., General Motors Corp.	145
International Harvester Co.	136
Kohler Co.	192
Koppers Co., Tar Products Div.	186
Le Roi Co.	188
Link-Belt Co.	133, 181
McDowell Mfg. Co.	196
Mechanics Universal Joint Div., Borg-Warner Corp.	140
Milsco Mfg. Co.	197
Morse Chain Co.	137
New Departure, Div. of General Motors	3rd cover
New Idea Farm Equipment Co.	191
The New York Air Brake Co.	184
Purolator Products, Inc.	141
Spraying Systems Co.	200
Stow Mfg. Co.	197
Timken Roller Bearing Co.	4th cover
The Torrington Co.	131
U.S. Steel Corp.	185
U.S. Treasury Dept.	199
Van Huffel Tube Corp.	183
Vickers, Inc.	144
Wisconsin Motor Corp.	194
Wrought Washer Mfg. Co.	193

Professional Directory

RATES: 80 cents per line per issue; 40 cents per line to ASAE members. Minimum charge, five-line basis. Uniform style setup. Copy must be received by first of month of publication.

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Agricultural Engineers YEARBOOK

The first edition of an ASAE-sponsored yearbook will be published and distributed to ASAE members early in 1954. It will be known as the AGRICULTURAL ENGINEERS' YEARBOOK, and each member will receive one copy without charge. It will be on sale to non-members at a price of $5.00 per copy.

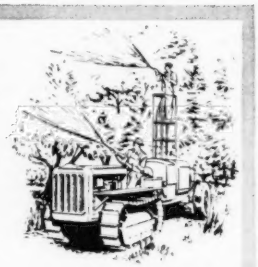
The Yearbook will contain a wide variety of information, for which ASAE members have frequent need. The main features will include (1) a roster of ASAE officers, divisions, sections, committees, and individual members; (2) the constitution, by-laws and rules of the Society; (3) standards, recommendations, and engineering data officially adopted or endorsed by the Society, and (4) a directory of manufactured products that agricultural engineers will find helpful in their various fields of activity.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS
ST. JOSEPH, MICHIGAN

SPRAYING SYSTEMS

GunJet®

SPRAY GUNS



dependable performance at all pressures

For effective spraying at any pressure from 30 to 800 pounds. Ruggedly built. Adjustable from straight stream to cone spray. Long life tips. Balanced for easier handling. Built by the makers of TeeJet Spray Nozzles. Write for Bulletin No. 65.

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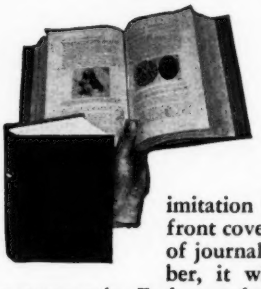

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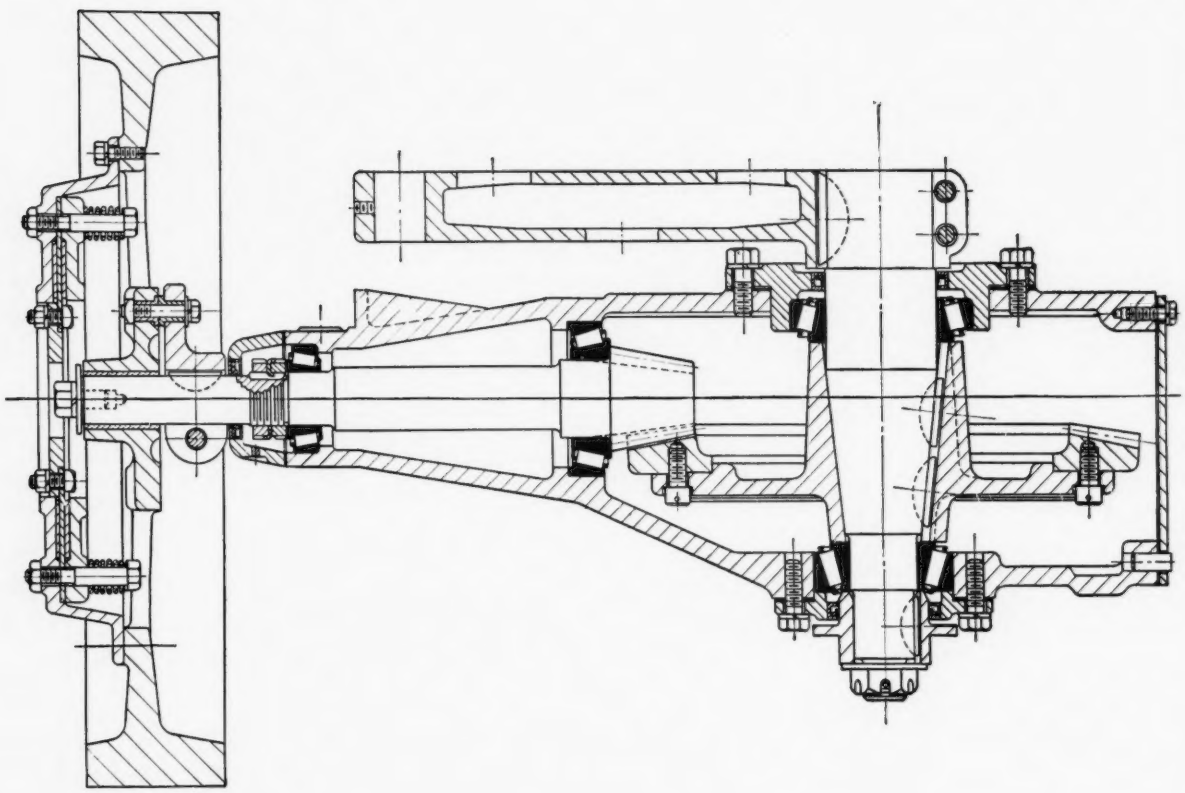

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